DECEMBER 28, 1959
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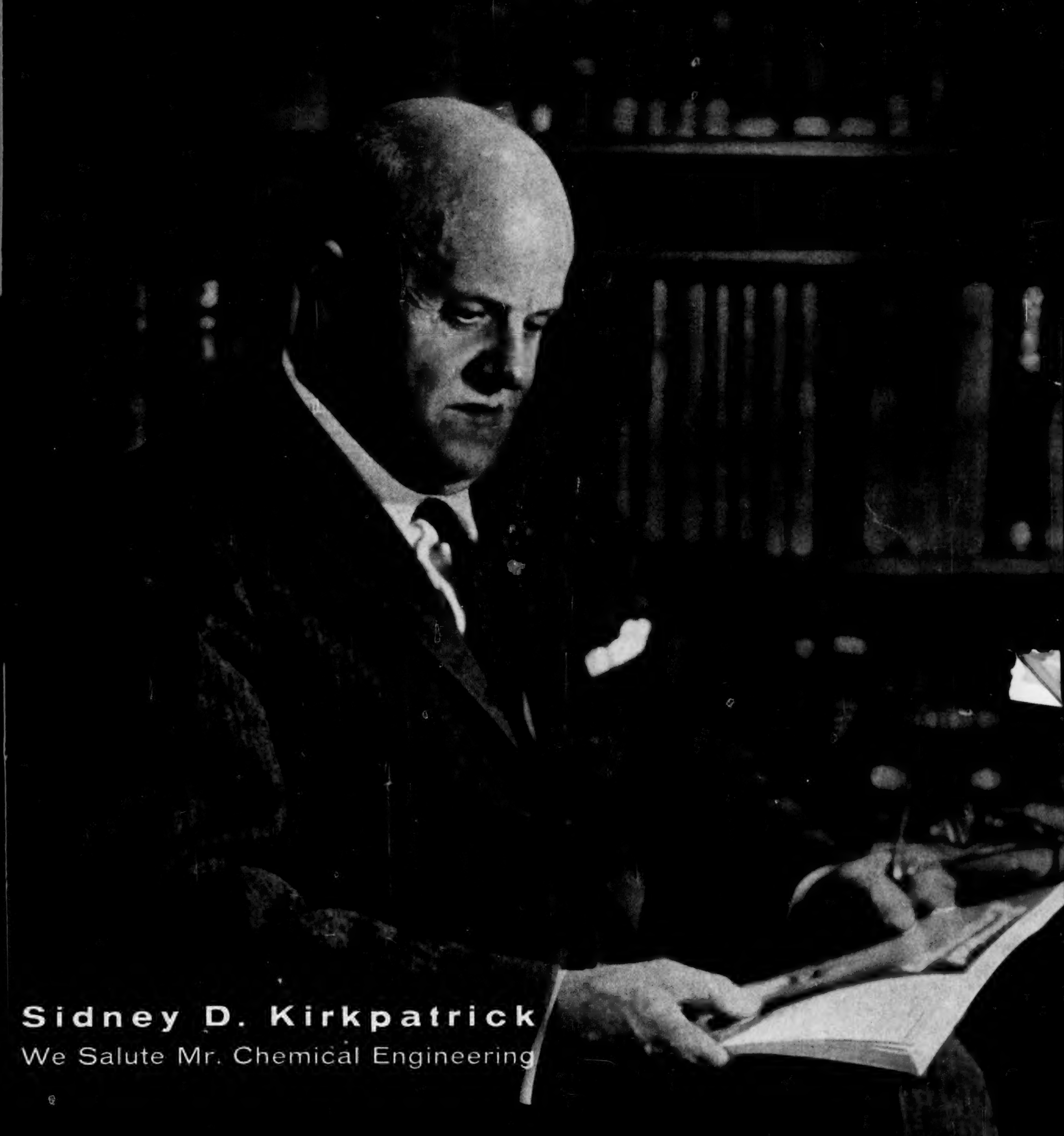
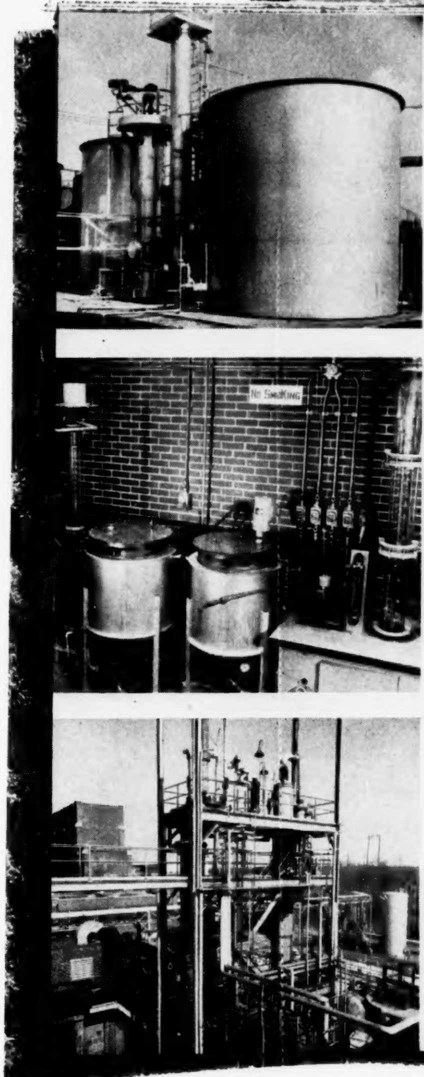
Chemical Engineering

A McGRAW-HILL PUBLICATION



Sidney D. Kirkpatrick

We Salute Mr. Chemical Engineering



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December 28, 1959 **Chemical Engineering** Vol. 66, No. 26

CHEMICAL TECHNOLOGY FOR PROFIT-MINDED ENGINEERS

CHEMICAL ENGINEERING DEVELOPMENTS

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CHEMICAL ENGINEERING PRACTICE

Contents continued . . . turn page

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Chemical Engineering December 28, 1959

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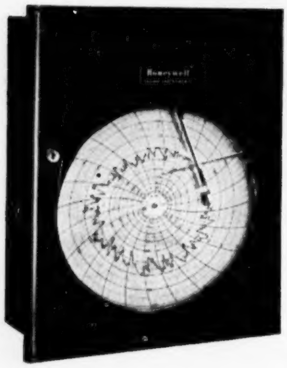
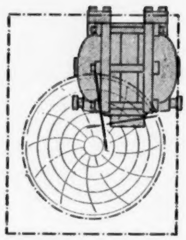
Honeywell Bellows Flow Meter

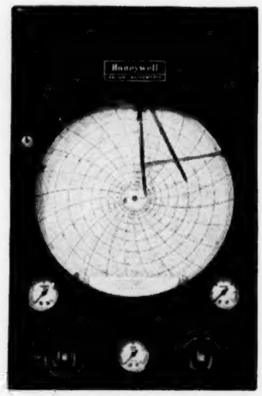
HERE ARE FOUR OF MANY WAYS YOU CAN USE THE BELLOWS FLOW METER

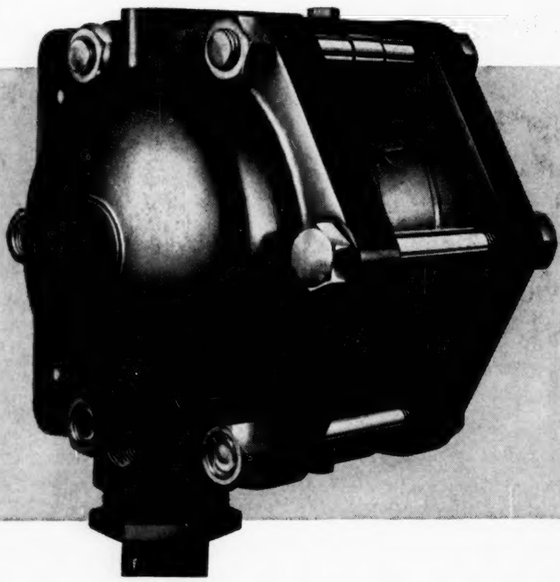


For direct measurement and control

the meter is integrally mounted on indicators, indicating controllers, recorders, or recording controllers.





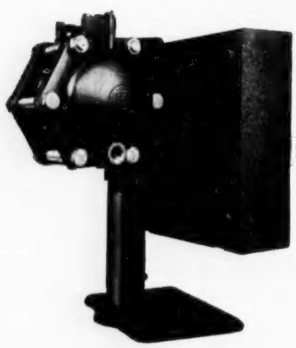


With an indicator or recorder— Indicators can be supplied with or without pneumatic transmission. Recorders can be one, two or three-pen instruments, with the second and third pens actuated by thermometer and/or pressure elements.

With indicating or recording controllers— All indicators and recorders can be supplied with any pneumatic control form from on-off to three-mode. Indicating controllers are also available with pneumatic transmission.

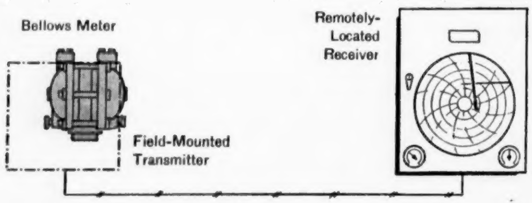
With a "blind" transmitter— the non-indicating differential pressure transmitter is used when indication is not required at the process and the variable is to be transmitted to remotely located instruments.

With an indicating transmitter— Scale is graduated in accordance with the flow or liquid level span of the transmitter. These transmitters are available with pneumatic control to remotely operate final control elements.



For remote measurement and control

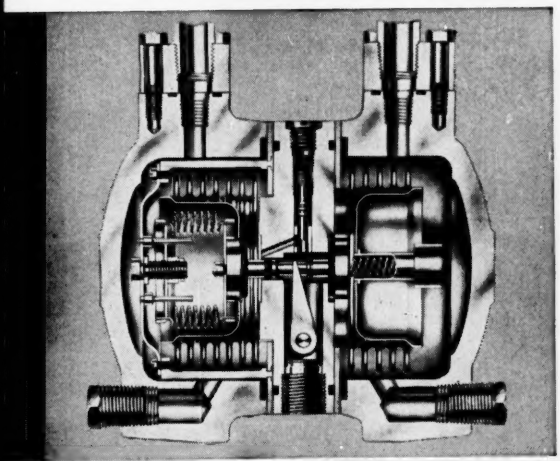
Field-mounted transmitters, either "blind" or indicating, can be used with remotely located indicators, recorders, and controllers.



and with <u>Tel-O-Set</u> miniature instruments and a variety of options!

has applications unlimited

Unequaled for accuracy, stability, versatility in flow and liquid level metering



Transfer of liquid between opposing high and low-pressure bellows converts differential pressure measurement into motion. A torque tube assembly carries the motion outside the meter body to an instrument. Therefore, changes in differential pressure change the instrument reading.

Here's the most advanced meter body available today, with advantages never before found in flow and liquid level meters. Combine the new Honeywell Bellows Flow Meter with the instruments shown on the facing page for truly superior service in metering steam, water, gas, oil and other fluids.

Some of its outstanding features:

Sensitive and accurate—Sensitive to within 0.05% of full scale . . . calibrated accuracy ± 0.5% of full scale.

Leakproof—Between liquid fill and process fluid.

Automatically stabilized—Changes in meter body temperature or static pressure have no effect on output shaft position. Meter operates efficiently in ambient temperatures of minus 40°F to plus 250°F.

Unmatched convenience features—Including fast range changing in the field . . . connections for both horizontal and vertical piping . . . quick calibration and adjustment . . . easy cleaning and servicing.

High corrosion resistance—Seamless, stainless steel formed bellows give long, trouble-free service with virtually all process fluids.

Fast, effective damping adjustment—New type pulsation check with rectangular orifice permits essentially linear damping adjustment . . . and adjustment from outside the meter body during operation.

Models are available in many ranges, for both flow and liquid level measurement and control. Get details on *all* the features of the new Honeywell Bellows Flow Meter by calling your nearby Honeywell field engineer today . . . he's as near as your phone.

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Honeywell

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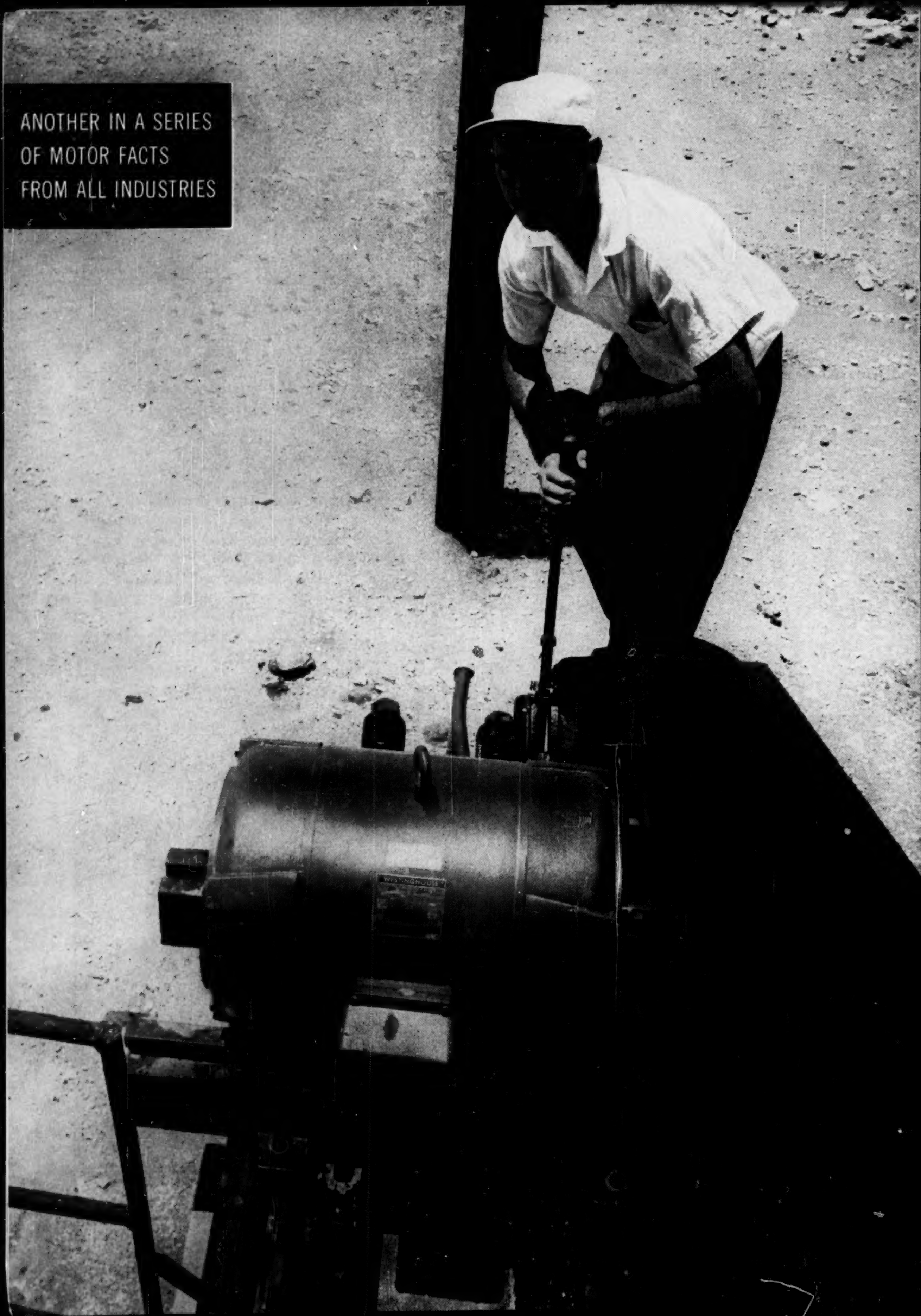
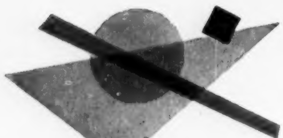

ANOTHER IN A SERIES
OF MOTOR FACTS
FROM ALL INDUSTRIES

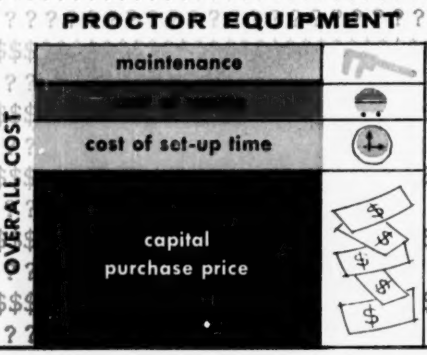


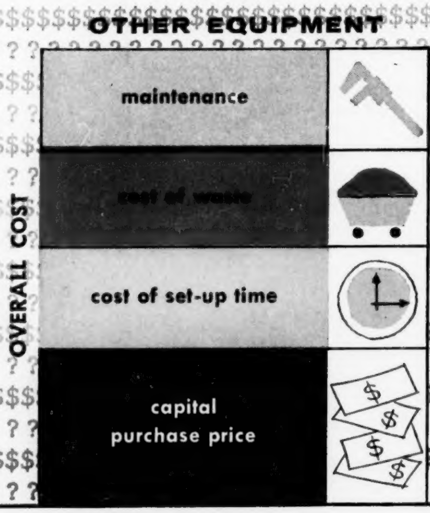
MODERNIZING WITH NEW EQUIPMENT?

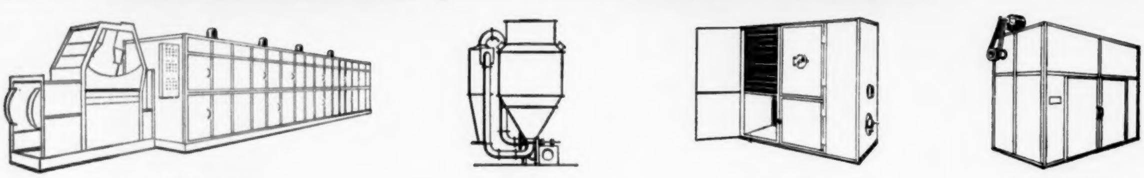
what will the REAL cost be?

REAL COST =

The purchase price can be the least of these over the years you will operate the equipment. PROCTOR users agree that the comparison of *real costs* often looks like this . . .







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Proctor

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Hackney Cylinders are "right" for any gas

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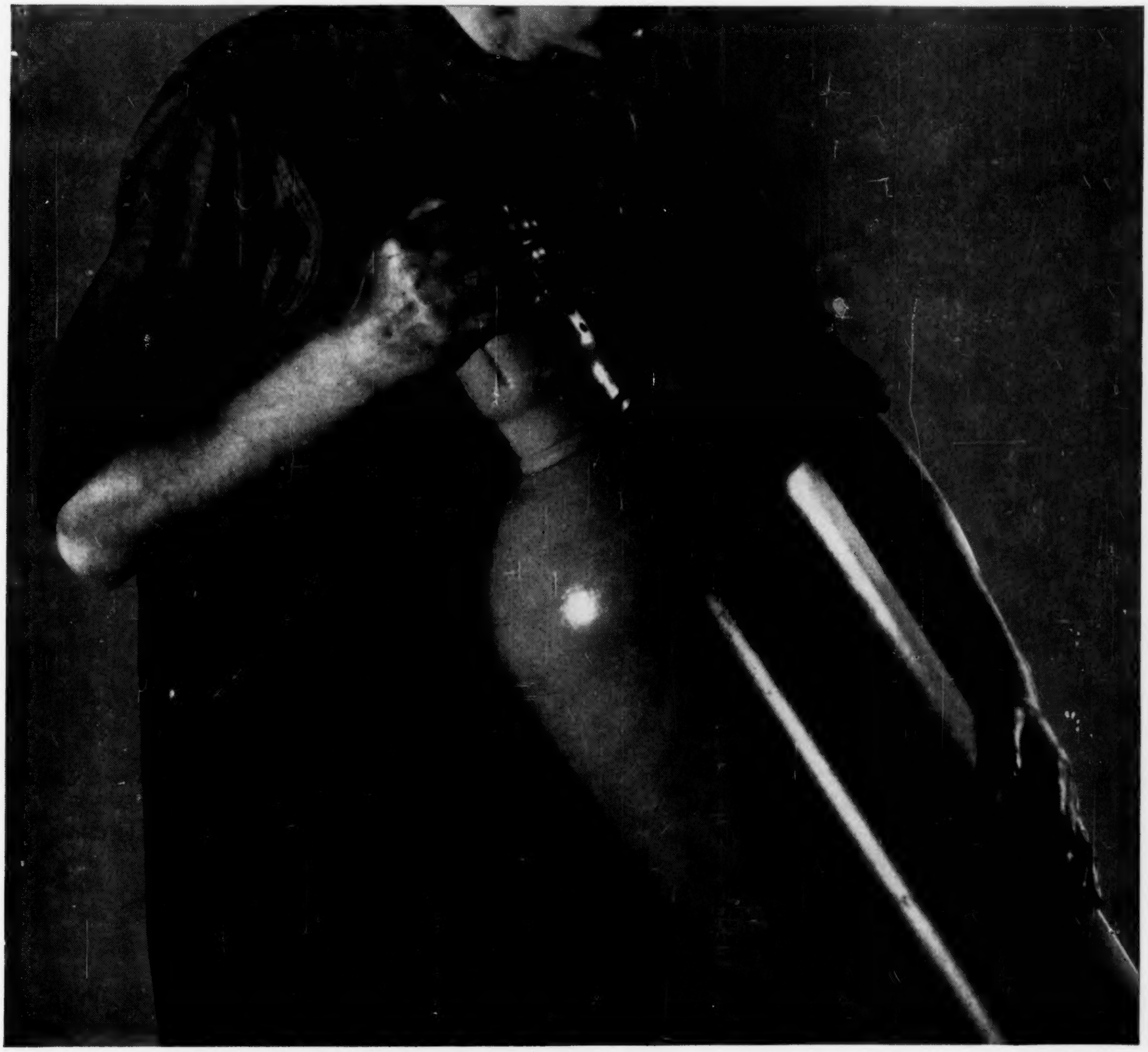
As a result, you save money on shipping costs... reduce handling charges...cut maintenance costs... speed filling operations...amortize your cylinder investment over shorter periods of time—and the smooth attractiveness of your painted cylinders makes your service welcome everywhere.

For complete facts and prices of Hackney high- or low-pressure cylinders, write to the address below.



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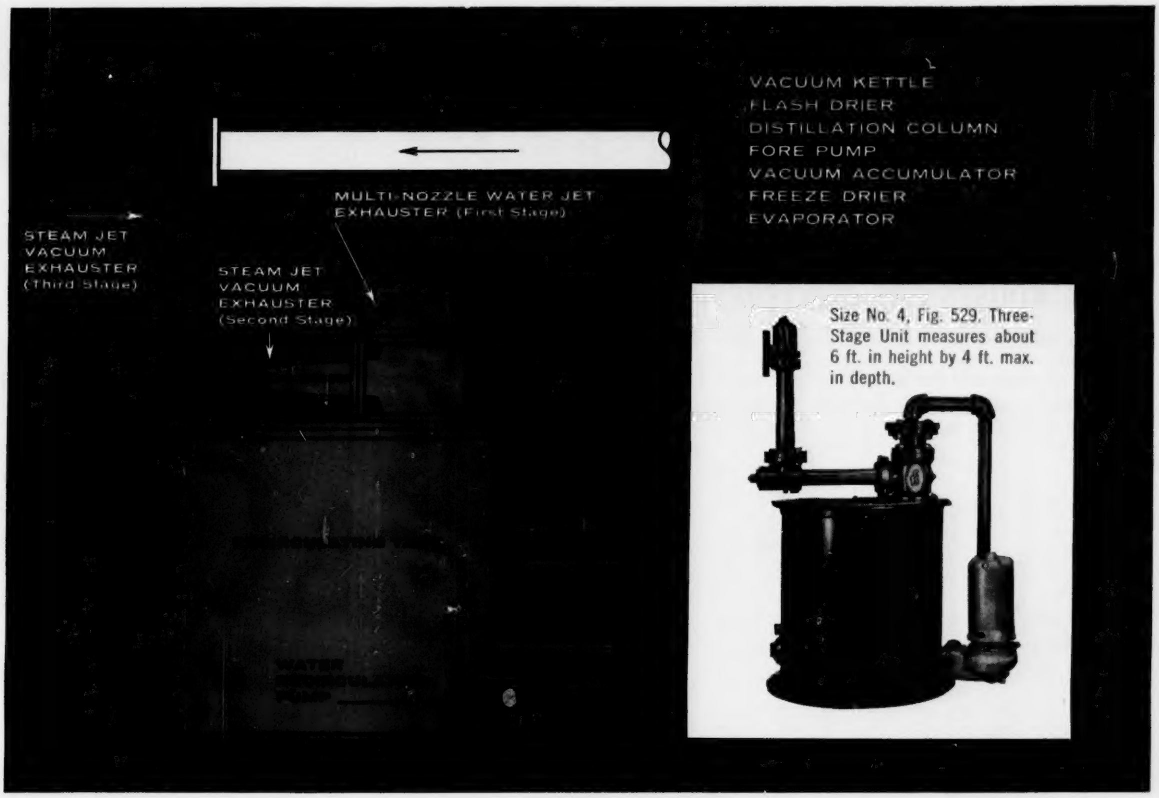
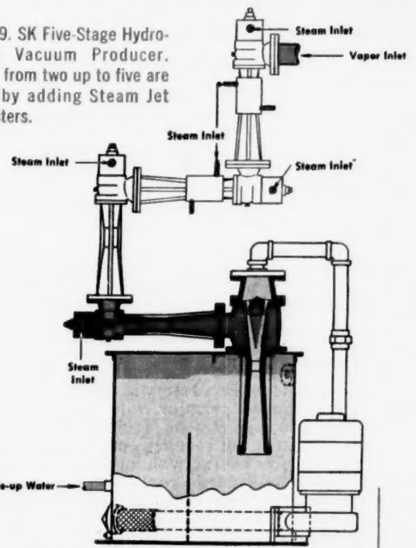


Size No. 4, Fig. 529. Three-Stage Unit measures about 6 ft. in height by 4 ft. max. in depth.

PRODUCE HIGH VACUUM QUICKLY & ECONOMICALLY

with this "Packaged" Hydro-Steam Unit

Fig. 529. SK Five-Stage Hydro-Steam Vacuum Producer. Stages from two up to five are made by adding Steam Jet Exhausters.



The unit shown is a "packaged" vacuum producer designed to operate at ground level. Using plant steam and make-up water, it will produce the low suction pressures required for many operations in chemical, food, and petroleum processing plants.

These units are made in a range of sizes in single-stage, two, three, four, and five-stage types. Depending upon size and type, units in this line will provide suction pressures ranging from atmosphere to 1.5 in. Hg abs (single-stage) up to 0.25 mm Hg abs to 25 microns Hg abs (five-stage).

SK "Packaged" Vacuum Producers offer specific, worthwhile advantages. They are simple in construction, are self-contained, compact, require little head room or floor space, are easily installed. Unlike mechanical vacuum producers, contamination presents no problems. They are operated easily, produce vacuum quickly, are economic, can be used intermittently or continuously as desired.

New Bulletin 5H-HS gives complete details on application, construction, operation including suction pressures provided and data on steam consumption and make-up water required. Send for a copy.

JET APPARATUS: Ask for Condensed Bulletin J-1.
ROTAMETERS & FLOW INDICATORS: Ask for Condensed Bulletin M-1.
VALVES: Ask for Condensed Bulletin V-1.
HEAT TRANSFER APPARATUS: Ask for Condensed Bulletin HT-1.
GEAR PUMPS: Ask for Bulletin G-1.

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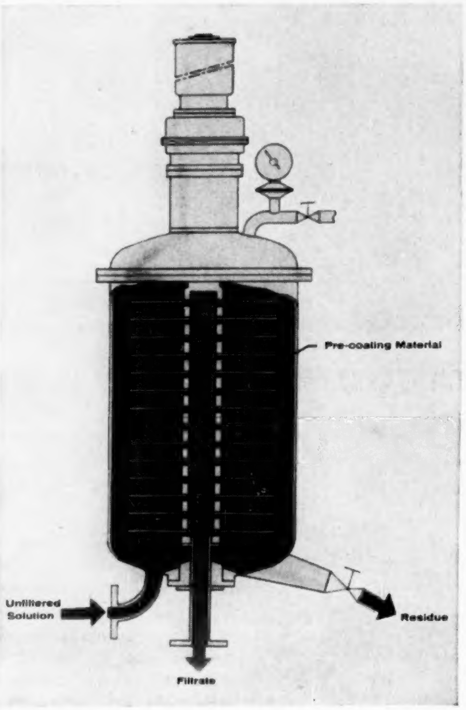
FLUID PROCESSING

RODNEY HUNT MACHINE CO., Process Equipment Division, 10 VALE STREET, ORANGE, MASS.

NEW RODNEY HUNT PRESSURE FILTER ROUSES GREAT INTEREST AT CHEM SHOW

At the Chem Show just a few weeks ago, Rodney Hunt introduced a new Pressure Filter with wide application in the process industries. Great interest was expressed by many visitors who indicated that the new equipment had a very great potential.

Adaptable to either solution clarification or dry cake recovery, the Rodney Hunt Pressure Filter is applicable to a wide range of products including pharmaceuticals, insecticides, plasticizers, dyestuffs, edible oils, plastics, resins, and many more.



The Filter operates semi-continuously, can be fully automatic, and offers top performance with greater capacity since there is virtually no downtime. This minimal downtime is the direct result of the fact that it is unnecessary to open the equipment for cleaning. The complete operating and cleaning cycle is carried out inside the closed filter.

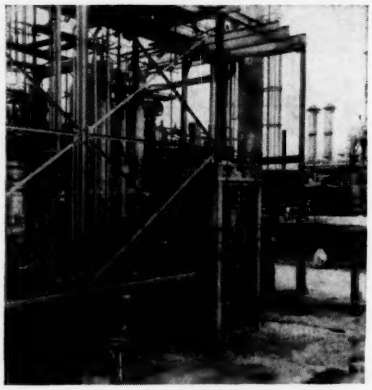
The Filter operates with equal efficiency both for clarification processes in which the filtrate is the end product and for operation where the residue or cake is the desired product, as in the production of salts, alkaline earths, dyestuffs, etc.

Since the Filter need not be opened for cleaning, labor costs are substantially reduced, and the filter elements are protected from accidental damage. The virtual elimination of downtime means that production capacity is greatly increased. And the Filter lends itself to efficient automation, since the complete operating cycle can be controlled automatically without manual operation.

The Pressure Filter can be automated in several various ways. One method is by a pneumatic system in which all valves are operated remotely from a central cycle controller adjusted to any desired time interval. In another method, the cleaning cycle can be initiated by a pressure relay which activates when the filter reaches a pre-selected value as a result of the gradual build-up of residue.

Rodney Hunt Pressure Filters are available in a wide range of sizes and models. The Laboratory Model has a filtering surface of approximately 2 square feet and can be used for either solution clarification or dry cake recovery. Industrial Models are offered in a variety of sizes with filtering surfaces up to as much as 250 square feet.

Write us if you would like more information about the Rodney Hunt Pressure Filter. A technical bulletin has been prepared which will indicate the ways in which this equipment may be applicable to your product or process.



TURBA-FILM PROCESSOR EFFICIENTLY DISTILLS HEAT-SENSITIVE PRODUCT

At a large, well-known chemical company plant in Texas, a Rodney Hunt Turba-Film Processor performs a vital function in the continuous distillation of a high-boiling, heat-sensitive organic product. Since installation early in 1959, the unit has given excellent service requiring only routine maintenance.

The plant occupies an 1100-acre site with deep-water dock facilities on the Neches River. Refinery gas is piped to the plant from Port Arthur, a few miles away, and the gas cracked and processed. When the plant was first built in 1946, the original major units were designed for the production of such basic petrochemicals as ethylene, ethylene oxide and ethylene glycol, the raw materials in the manufacture of many other synthetic organics. As the company's research and development program led to new processes and products, additional facilities were built to produce ethanolamine, oxide specialties and ethylene dichloride.

A recently completed expansion program has tripled facilities for ethylene, doubled the plant's capacity for ethylene glycol and increased production of ethylene oxide 50%.

The selection of the Rodney Hunt Turba-Film Processor was made on the basis of extensive tests conducted at the Rodney Hunt Laboratory at Orange, Massachusetts, in cooperation with engineers from the company. The Turba-Film Processor that met the requirements is approximately 13 feet overall with an outer diameter of 32". All parts in contact with the process fluid are constructed of stainless steel and the remainder of carbon steel. The stainless steel rotor is machined to a blade clearance tolerance of .030 to .035 inch.

The ability to process heat-sensitive products such as in this installation is one of the major advantages of the Rodney Hunt Turba-Film Processor. Since processing is accomplished in one pass, continuously and rapidly, only small amounts of the product are in process at any given moment and thus only briefly in contact with heat.

Pratt & Whitney has test fired first liquid-H_2-fueled rocket engine. Called XLR 115, unit has been named to power upper stages of Atlas, Saturn missiles.

Dow's Zefran may be a radiation-induced graft copolymer. Well-informed sources declare acrylonitrile polymer is modified by vinyl pyridine graft.

Hercules is exploring use of nuclear reactor for radiation chemical processing. Company says it synthesized ethylene glycol by passing reactants through reactor core.

Vapor compression is process for Interior's fourth seawater desalting plant. A 100,000-gal./day unit will be built in the Northern Great Plains or Southwest.

Polybutylene close to commercialization

Plastic on the next rung up the polyolefin ladder—polybutylene—is edging closer to commercialization. Petro-Tex Chemical (Houston) revealed that it has been conducting intensive pilot plant studies on the material, indicates now it's readying polybutylene for the commercial arena.

Montecatini has already gone on record as having brought polybutylene to the pilot plant stage (*Chementator*, June 29, p. 37). And a group of U. S. firms including Hercules, Spencer and Goodrich-Gulf have acknowledged that they are seriously investigating the polyolefin in their labs.

Behind growing interest in the polymer: polybutylene looks like a standout material for heavy-duty applications such as in plastic pipe and packaging films where long life and exceptional resistance to stress and strain are needed. Reports Petro-Tex, polybutylene film has almost twice the impact resistance and tear strength of polyethylene. And when extruded into pipe and tubing, it exhibits higher burst strength and stress resistance. Still another attraction: Petro-Tex's pilot plant studies indicate cost of polybutylene should be about the same as polyethylene; in some cases, since greater amounts of filler such as carbon black can be used without loss of desirable properties, polybutylene would be cheaper.

Continuous U-fuel making in fluid beds

Fluid-bed processing shows promise of putting Britain's batch route to uranium tetrafluoride on a fully continuous basis. U. K. Atomic Energy Authority reports that it plans to pattern its second commercial feed-materials plant—a \$36-million, 1,000-ton/yr. facility destined for Springfield, England—after a successfully operated fluid-bed pilot unit there. In the U. S., Allied's General Chemical has already harnessed fluid-bed processing to the job of continuously making uranium hexa-

Photo shows Feraloy Condulet conduit fitting after several years exposure to hydrochloric acid. Note extreme deterioration of conduit.

CROUSE/HINDS

Condulet®

electrical equipment

the one complete line for corrosive locations

RESISTS chemical and galvanic corrosion

RESISTS acids, alkalis, salts

RESISTS varying concentrations and temperatures of corrosive liquids, vapors, gases, dusts

Corrosion problems would be simple if there were a single material which would resist all corrosive substances.

Since there is not, Crouse-Hinds provides electrical equipment in four materials which offer a selection to meet virtually every known corrosion problem . . .

FERALOY® features the desirable characteristics of cast iron: strength, corrosion resistance, versatility, adaptability, economy. Plated with zinc and cadmium, Feraloy Condulets will combat most corrosive elements.

ALUMINUM ALLOY develops its own self-repairing oxide film which resists a number of corrosive conditions. Copper-free Aluminum Alloy Condulets effectively resist galvanic corrosion.

PLAST-A-COAT, a polyvinyl chloride, is a resilient coating which withstands abrasion and repels corrosion from caustics, alkalis and heavy mineral acids. Tough, non-peeling, it also acts as an insulator.

SILICON BRONZE, when all other materials fail, can be furnished for the most extreme corrosion problems. Counteracts virtually all alkalis as well as salt water, sulfur gases, etc.

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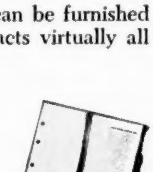
containing full information on Crouse/Hinds Condulets for Corrosive Locations.



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Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

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fluoride at its 5,000-ton/yr. plant at Metropolis, Ill.

Use of fluid beds, both AEA and General Chem point out, improves gas-solid contacting, temperature uniformity and control, ups yields and garners better process economics. In the English plant, fluid beds will serve in three processing steps—denitration of uranium-ore-concentrate leach liquor to solid uranium trioxide (orange salt), reduction of orange salt to uranium dioxide, and hydrofluorination of dioxide to tetrafluoride (green salt). General Chem employs fluid-bed processing only in the last two operations; it uses furnace denitration for the first step.

Hydrofluorination poses the toughest process problems because exceptionally close temperature control is required in the reaction. General Chem uses two fluid-bed reactors in series to handle the job. First unit runs at 660 F., just below sintering temperature of UO_2; reaction proceeds to more than 95% completion. Second reactor completes reaction, operates at 1,100 F. to prevent reaction reversal. AEA reports that it feels it can get needed temperature control in a single fluid bed. But to maximize process economics, AEA concedes, it will have to recover HF from reactor off-gases by distillation. U. S. firm maintains it gets nearly complete HF utilization with the twin-bed set up.

Another key point of difference: General Chem pre-forms orange-salt feed to the reduction reactor, claims this eases temperature control in both reduction and hydrofluorination reactors, also minimizes plugging in those units. AEA plans to sidestep this procedure.

New engine teams jet, piston merits

Curtiss-Wright, teamed with West Germany's NSU Werke, has come up with a radically new internal combustion engine that boasts only two moving parts, combines the high efficiency of reciprocating piston engines with the work continuity of jet engines, is of lower weight and smaller size than comparable piston units and should sell for an attractively competitive price. Described as a rotating combustion engine, new unit is expected to find wide applications in industrial equipment such as compressors, generators and pumps, as well as on automotive, aircraft and marine power jobs.

C-W plans to be in commercial manufacture by early next year with sizes of 100-700 hp. Moreover, it currently has in an advanced stage of development units in the 750-5,000-hp. class. Team-mate NSU is concentrating on building engines in the 5-100-hp. class, a field which the U. S. firm also plans to enter in the near future.

Heart of the new design is a combustion chamber in which a three-sided rotor turns. A carburetor feeds gasoline-air mixture through a side-wall port into one of the three chambers formed by the rotor lobes. As rotor turns, mixture is compressed and fired by a single spark plug. Exploding gases deliver power to a crankshaft connected to the rotor; exhaust gas exits through a second port in the chamber. Three power sequences per rotor revolution maintains almost continuous intake, compression, ignition, expansion and exhaust cycle.

Unit's only moving parts are rotor and crankshaft; no valves, springs, camshafts, connecting rods, etc., are required. Absence of reciprocating parts, notes C-W, eliminates vibrations and assures smooth operation. Lack of "hot parts" such as exhaust valves and turbine blades cuts down on use of costly materials of construction. Furthermore, engine doesn't need premium fuels, runs at high efficiency on auto gasoline. Fuel consumption is lower than 0.45 lb. gasoline/hp. hr.

Coal-gasification project abandoned

Dogged by unfavorable economics, projects to gasify coal seem unable to advance much beyond the pilot plant stage in the U. S. though they go commercial quickly enough elsewhere in the world.

Case in point: North Dakota Nitrogen Co. It has abandoned plans to produce synthesis gas and nitrogen fertilizers from North Dakota lignite, instead is turning to natural gas for its raw material.

Originally, company, which is closely associated with Chemical and Industrial Corp. (Cincinnati) through a consulting contract and an interlocking directorate, had planned to build a 170,000-ton/yr. nitrogen fertilizer plant at Riverdale, N. D., to tap a 2-million-ton pile of lignite unearthed by Army engineers while constructing the Garrison Dam on the Missouri River. But NDN's technical and economic studies have since disclosed that natural gas, despite its steadily rising price,

(Continued on p. 22)

What's new in processing chemicals?

DOW

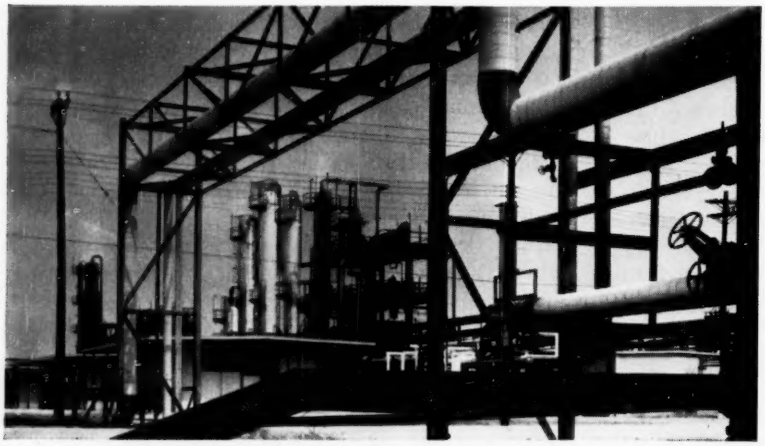
News has a cash value for the chemical processor. Whether it's about new products or new applications for familiar products, this news can make the difference between keeping ahead of competition and having to catch up with it. This series of chemical news notes is designed to help you keep products, processes . . . and profits up to date.

You may wish to check certain items in this advertisement and forward to those concerned in your company.

ROUTE TO:

GLYCERINE FORECAST: BRIGHT FUTURE FOR VERSATILE WORKHORSE CHEMICAL

Since development of the synthetic product in 1947, glycerine has enjoyed an extension of usefulness because of improved purity made possible by its chemical production. Today, new improvements in manufacturing techniques have upgraded Dow's synthetic glycerine. As a result, profit-minded production men are presently re-evaluating glycerine as a replacement for more expensive processing chemicals.



Production facilities for Dow's synthetic glycerine at Freeport, Texas.

Long a favorite "workhorse" chemical in the chemical processing industry, glycerine is, of course, well known chemically and physically.

Glycerine's versatility is exemplified by the unusual number and variety of derivatives that can be formed by reaction with other chemicals. Typical of many useful types of glycerine reactions possible are: etherification, amination, and reaction with alkali metal hydroxides.

PHYSICAL TALENTS, too, account for the many millions of pounds of glycerine that go into nonchemical uses. Here it functions as plasticizer, humectant, solvent, bodying agent, and lubricant, in a variety of product roles. Glycerine is "made to order". It stays free from objectionable color, odor or taste almost indefinitely. Along with its stability, other talents pressed into service in varying combinations include its hygroscopicity, low volatility, solvent power and solubility, high viscosity, noncrystallinity, low toxicity, compatibility, and taste (sweet and pleasant).

The glycerines from Dow are three: GLYCERINE SYNTHETIC is the indicated choice in nearly all industrial applications (including lighter colored alkyd resins in paints). GLYCERINE, USP was developed to meet U. S. Pharmacopoeia requirements, including glycerol content of 95%. Dow's quality runs, in fact, 96%—a strength many users wish because: the viscosity is considerably below that of 99.5%. It is easier to handle, and does not freeze easily. Color is water-white for uses requiring high purity, with taste and odor characteristics desirable for pharmaceutical and food uses.

And glycerine, U.S.P. 99.5% – preferred by customers who find the 4% water in U.S.P. undesirable in their processes. It is identical with U.S.P. except that glycerol content is a minimum of 99.5% instead of 96%.

THE BASIC FACT behind the high quality of Dow's three fine grades of synthetic glycerine is this . . . Dow makes all of the ingredients that go into glycerine production. This means assurance of quality and abundant supplies that can result only from complete control of raw materials from

the original source to the finished product. Wherever long range industrial plans concerning processes and products require glycerine of consistently high quality, Dow will deliver it promptly . . . in drums, tank cars or shiploads . . . from bulk stock points located at Bayonne, New Jersey; Chicago, Illinois; Freeport, Texas; Oakland, and Torrance, California.

CAUSTIC SODA—

coming at you 14 ways

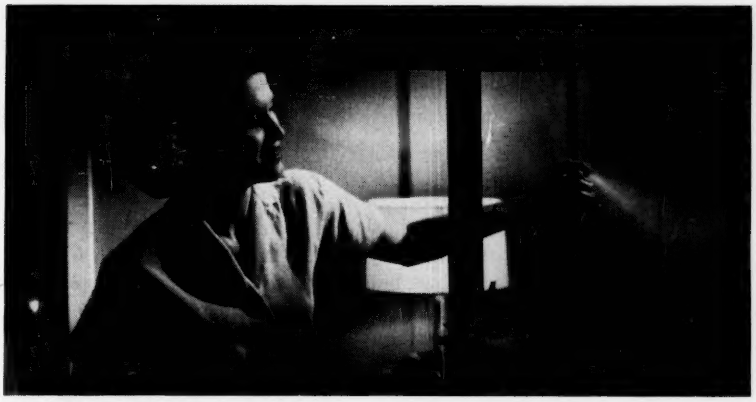
Early this year, when construction was completed on a distribution terminal in St. Louis, Missouri, the number of caustic soda terminals maintained by Dow across the country came to nine.

Last October, a multimillion dollar plant for 50% and 73% caustic soda went into production at Plaquemine, Louisiana, ten miles south of Baton Rouge. With plants in Michigan, Texas, California and Ontario, Dow now has a total of five production plants.

All together, this brings to fourteen the number of shipping points operated by Dow, coast to coast, for caustic soda, bulk or dry, delivered by barges, tank cars and trucks. Behind this distribution service is a technical service that's second to none in solving problems for manufacturers in every industry.

★ ★ ★ ★

WE HAVE ROOM here for only a few notes on but a small percentage of all the chemicals we supply. For information in depth on any chemical, we invite you to write THE DOW CHEMICAL COMPANY, Midland, Michigan, Chemicals Merchandising Department 992AK12-28.



CHLOROTHENE . . . cost cutter for aerosols

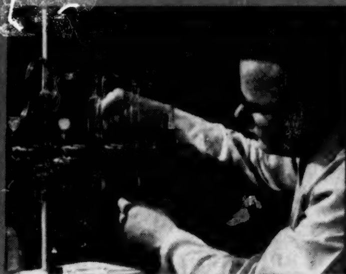
Lowering of unit costs is the goal of all manufacturers. One path to this goal in aerosol products is the use of a versatile Dow solvent, Chlorothene®, (1,1,1-trichloroethane, inhibited).

Lower cost is but one advantage. Others include excellent solvency for active ingredients, reduced container corrosion in certain formulations, and the elimination of the need for odorous and highly flammable solvents. Additional information on Chlorothene, its uses, properties, costs and past performances is immediately available.

4 NEWS NOTES on other chemicals . . .

DEVELOPMENTAL CHEMICALS

Research chemicals currently available in limited quantities from Dow are listed by name, structural formula, description, property data and size of sample in a new 56-page booklet entitled "Research Chemicals from Dow".

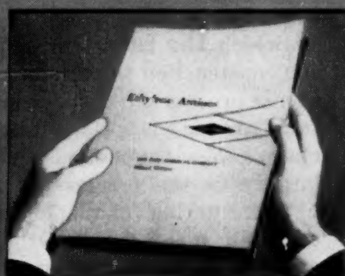


ALKANOLAMINES

If you are interested in discussing emulsion formulation in such fields as pharmaceuticals, cosmetics, agriculture, and home use wax and polish products, Dow technical service and development men can help you.

DOWANOL

Dow offers the only line of glycol ether solvents including both an ethylene and propylene series of products trademarked Dowanol®. Their broad use as chemical intermediates and their versatility as solvents make them very popular.



ETHYLENE AMINES

A new technical treatise, recently made available to chemists and engineers, discusses Dow's ethylene amines—ethylenediamine, diethylenetriamine, triethylenetetramine and tetraethylenepentamine. Send for this informative book.

DOW CHEMICALS

basic to the chemical processing industries

Alkylene Oxides, Glycols
Industrial Preservatives • Glycol Ethers
Polyalkylene Glycols • Alkalies
Phenolic Compounds • Brominated and Chlorinated Aliphatic Compounds
Inorganic Acids—Halogens
Organic Acids and Esters • Amino Acids
Inorganic Chlorides • Salicylates
Bromides and Bromates • Glycerine
Nitrogen Compounds
Phenyl Phosphates • Heat-Transfer Media

THE DOW CHEMICAL COMPANY
Midland, Michigan

DOW

is still the far more economical raw material for synthesis gas and fertilizer manufacture. Declares the company, use of natural gas rather than lignite will slice plant construction costs by $1.5 million, allow for cheaper and more efficient production of fertilizer.

With much the same objectives in mind, Bureau of Mines also has been exploring the feasibility of gasifying North Dakota lignite in a modified Lurgi-gasifier pilot plant at Grand Forks, N. D. (*Chementator*, Nov. 3, 1958, p. 52). As yet, however, BuMines is still wrestling with hardware, can not predict commercialization of its work. And other U.S. coal-gasification projects continue to be, at best, only in the advanced pilot plant stage.

It's a different story in Europe. England's West Midlands Gas Board begins construction next month on a $25-million Lurgi plant to produce 40 million cu. ft./day fuel gas from 410,000 tons/yr. coal when on stream late in 1963 at Coleshill, England. It's the second such plant for Britain; the first is being built by the Scottish Gas Board (*Chementator*, Mar. 24, 1958, p. 58). And Russia this month started up its huge underground coal gasification plant at Angrenski, Uzbekistan. Electrically ignited coal reserves, estimated at 45 million tons and some 360 ft. below the surface, will deliver gas at the rate of over 66 billion cu. ft./yr.

Cane-sugar diffusion back in news

After almost five years of virtually complete silence on the matter, Chemetron Corp. has reactivated efforts to market its continuous diffusion process for extracting sugar from sugar cane (*Chem. Eng.*, July 1955, p. 124). Company has tied up with J. G. White Engineering (New York) in an arrangement by which the latter will supply engineering and construction services, and Chemetron will license process and supply equipment. And this time around, reports White, several sugar makers have expressed definite commercial interest in the process.

Accounting for the dormancy of the process these many years is the fact that, from an engineering standpoint at least, initial announcement of the sugar diffusion flowsheet was considerably premature. Though declining to cite specific details, White notes that substantial operating bugs had to be ironed out of the process over two sugar-crop seasons in a 150-ton/day pilot plant (at the sugar mill of Fellsmere Sugar Producers Assn. in Fellsmere, Fla.) before it could be considered seriously for commercialization. Moreover, company needed to work up detailed economic evaluations to substantiate claims made for the process when initially announced.

White's economic study now shows that a sugar factory's profit picture, before taxes, would be improved by more than 50¢/ton of cane when using the Chemetron process instead of usual milling route, company asserts. And diffusion process will cut investment costs by 25%, extraction costs by over 10%. Too, Chemetron claims up to 98% sugar extraction of about 87% purity which results in 6-8% more sugar in the bag.

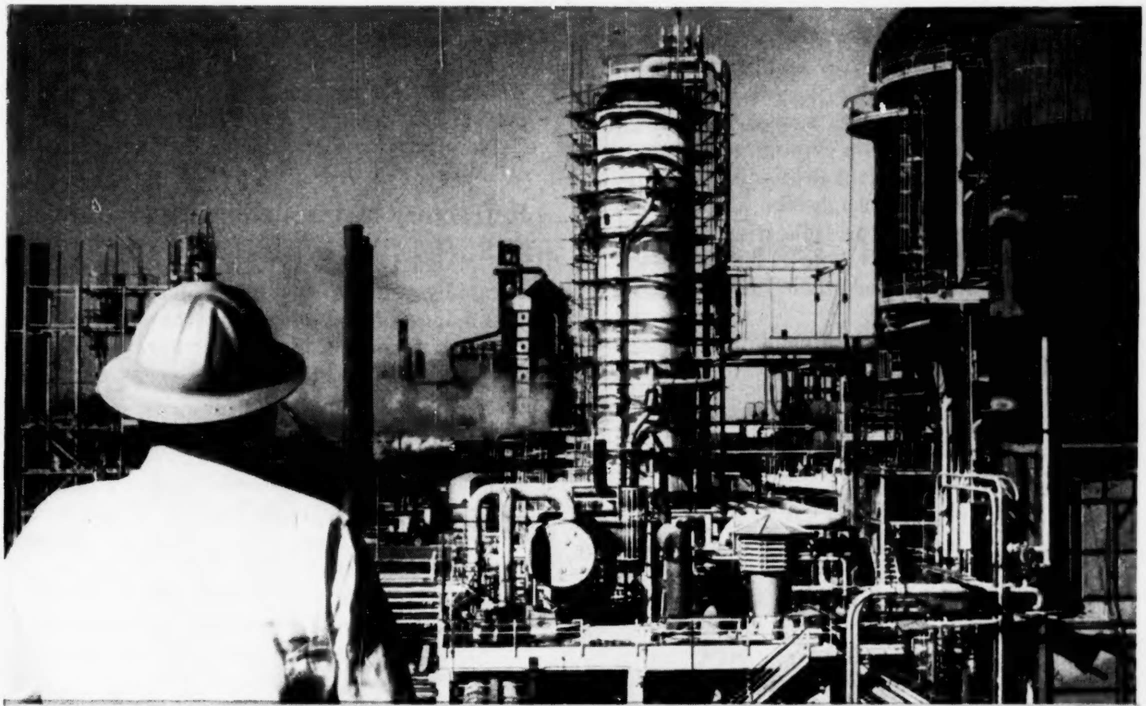
During time Chemetron has been readying its flowsheet, another diffusion process has appeared on the scene. Hawaiian Sugar Planters Assn. is piloting a cane-sugar diffusion flowsheet at Kekaha Sugar Co., reports sugar extraction of 95% and expects 98% with minor engineering improvements. Hawaiian route has processed 10,000 tons of cane in a 17-ton/hr. diffuser built by Silver Engineering Works (Denver).

New vacuum process degasses steel

A new vacuum process for degassing steel, invented by Germany's largest steel maker, Dortmund Horder Hutteunion, is getting its first full-scale commercial tryouts in the U.S. Lectromelt's Vacuum Furnace Div. is installing a 1-million-ton/yr. unit for Crucible Steel and a 300,000-ton/yr. plant for National Forge, both designed to produce high-quality, special-purpose steels.

Prime virtue of the process: It provides considerably longer contact time—30 sec. compared with 1 sec.—between steel to be degassed and vacuum than currently used processes. This achieves a higher degree of oxide, hydrogen and nitrogen removal, so turns out steel of improved hardening, drawing, machining and mechanical properties. Moreover, unlike present degassing processes, the German route is readily adaptable to a number of different steel-making facilities such as open-hearth, electric-furnace or oxygen converters. This offers steel makers greater flexibility in quality ~~products~~ they produce.

According to Lectromelt, new degassing vessel resembles a giant Silex coffee machine. A ladle of molten steel is moved under the unit and bottom port of degasser is lowered



into the melt, sealing the vessel. A vacuum pulled from the top creates a 55-in. head which forces molten steel up through a pipe into the chamber where violent degassing takes place. Breaking vacuum sends the degassed steel surging back into the ladle with nearly complete mixing. Usually 20 to 30 dips are required to degas a melt; the whole cycle takes 18-20 min.

At Crucible, each dip will draw up 25 tons of metal from a 200-ton ladle, take about 30 sec. Alloying metals can be added toward end of the degassing cycle since there are no impurities left to tie up alloying elements.

California cars to get anti-smog unit

Auto makers have bowed to the campaign of California anti-smog warriors (*Chem. Eng.*, Dec. 14, p. 86). Automobile Manufacturers Assn. disclosed earlier this month that an anti-smog device will be offered for installation on all 1961 cars for sale in California.

But the device to be used, developed through a joint auto-industry program, takes a surprisingly new tack in tackling the smog problem. Rather than attacking auto exhaust with catalytic afterburners as has been widely proposed, unit is designed to cut off release of crankcase fumes. Claims AMA, these fumes are responsible for a "substantial portion" of smog-forming hydrocarbons produced by cars. Device, described as an uncomplicated system of piping and valves, returns crankcase fumes, usually vented to atmosphere through a breather, back to engine's intake manifold.

All five auto makers are now tooling up for production of the device but haven't yet decided whether it will be an added-cost item on California cars or installed free of charge. In any case, says AMA, it would cost only a "few dollars."

Despite this innovation, auto makers and others continue research on methods to remove smog-forming constituents in auto exhausts. Franklin Institute, under sponsorship of Air Pollution Foundation of San Marino, Calif., has come up with a device to remove nitrogen oxides from exhaust gases. It uses chromite catalysts such as zinc-copper chromite and iron chromite to promote reduction of NO by carbon monoxide, has netted better than 90% nitric oxide removal.

Another technique: A fuel injection system using a 30:1 air-fuel mixture that reduces unburned hydrocarbons in exhaust to about 2% of original fuel weight. Invented by Ralph Heintz, former partner of Jack & Heintz, Inc., system is currently under test by Stanford University, Chrysler and Food Machinery.

Refractory metals mate with graphite

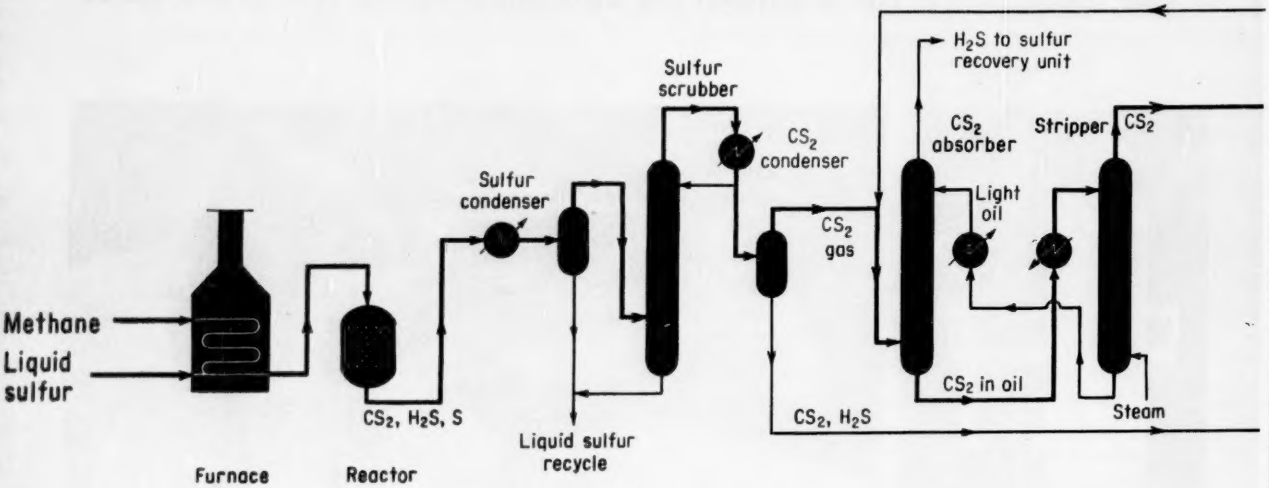
Marriage of refractory metals to graphite is rapidly gaining boosters as an exceptionally promising way of answering the space age's burgeoning need for high-temperature-resistant materials. And in recent weeks at least four firms have unveiled new or improved techniques for accomplishing these matings.

- Falls Industries, in league with American Metal Products, reports that it's experimenting with the impregnation of graphite with titanium vapor. Claims company, material so produced maintains heat-transfer properties of graphite, adds temperature resistance (upwards of 2,000 F.) and corrosion resistance (e.g., against nitric acid, sulfuric acid and hot, wet chlorine) of titanium.
- Linde Co. reports that it has developed means of applying tungsten directly to graphite with its Plasma Arc Torch (*Chem. Eng.*, Dec. 29, 1958, p. 24) without the use of expensive undercoatings such as rhenium. Claims company, material so produced withstands flame temperatures around 5,500 F. and pressures of 500-1,000 psi.
- Metallizing Engineering Co., which offers commercial plasma-spray equipment, tells *CE* that it has developed a new unit that can spray-coat titanium directly on a completely unprepared graphite surface.

Falls Industries' development is a direct descendant of such established materials as silicon-carbide-impregnated graphite and furane, epoxy and phenolic resin-impregnated graphite (e.g:, Karbate, Impervite). Though more costly than any of these, titanium-graphite holds much greater potential for high-temperature service, Falls maintains.

American Metal Products performs the titanium impregnation of graphite components such as rocket nozzles and heat exchangers fabricated by Falls. Titanium vapor is injected into a vacuum furnace containing heated graphite parts. Metal penetrates surface and reacts with carbon to form titanium carbide. Process can be controlled to give thin titanium carbide layer or can be carried to the point where the whole graphite piece takes on the appearance of titanium.

For more **DEVELOPMENTS**............26



Another Boost for Petrochemical CS_2

Stauffer's recent decision reaffirms the commercial success of the petrochemical CS_2 process and seals the doom of the charcoal-sulfur route.

Petrochemical route to carbon bisulfide has just received a vote of confidence from a satisfied customer: Stauffer Chemical, which already uses the process at LeMoyne, Ala., is building a second plant at Delaware City, Del. Capacity of the new facility, due on stream in November 1960, has not been announced, but Stauffer says output will be going into cellophane, rayon and chemical intermediates. Stauffer adds that it is considering shutting down some of its older plants that use the charcoal-sulfur process (*Chem. Eng.*, Jan. 1951, pp. 174-177).

Based on original research by Pure Oil, petrochemical CS_2 process uses a vapor-phase reaction of sulfur and methane over a silica gel catalyst. Besides Stauffer, process is also employed by Columbia-Southern at South Charleston, W. Va., and in a plant jointly owned by Westvaco and Allied Chemical also in South Charleston.

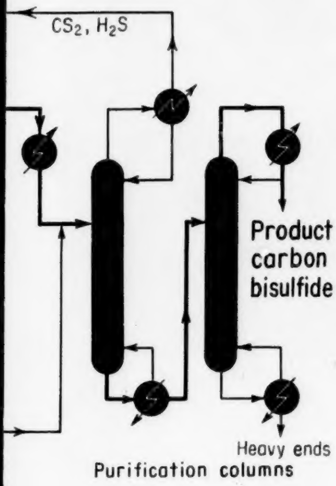
▶Start With Methane — Little has been published about the petrochemical CS_2 process, but it is believed the new Stauffer plant will use a flowsheet similar to the one above.

Purified methane at about 60 psig. and liquid sulfur in about stoichiometric proportions pass through a furnace where the sulfur vaporizes and mixes with the methane at around 1,200 F. Preheated vapor passes to the reactor where the following reaction takes place over silica gel:

$$CH_4 + 2\,S_2 \longrightarrow CS_2 + H_2S$$

Conversion is about 90-95%. Vapor stream from reactor containing CS_2, H_2S and unreacted sulfur passes to a condenser where sulfur condenses and is recycled. Gas stream at about 100 F. still contains some sulfur and passes to a scrubber where sulfur condenses against CS_2.

▶Absorb and Distill — After partial condensation of carbon



bisulfide from the scrubber effluent, gas stream flows to an absorption tower where remaining CS_2 is absorbed in a light oil solvent. Off-gas from the absorber, containing 90-95% H_2S, passes to a sulfur recovery unit where H_2S is oxidized back to elemental sulfur and is recycled.

Oil containing the CS_2 flows to a stripping column where steam distills out the carbon bisulfide. Overhead CS_2 flows to a distillation column where remaining traces of H_2S are removed. Bottoms from this column is pumped to a final distillation stage where heavy ends drop out. Overhead from this column condenses and is washed with caustic soda to remove any sulfide traces.

Since ignition point of carbon bisulfide is only 230 F., great care must be exercised both during manufacture and storage. To avoid contact with air, CS_2 is always stored under a blanket of water and storage tanks themselves are usually submerged in water to eliminate any danger from possible leaks.

More Who's Who In Polypropylene

Two more pieces have fallen into place in the big picture sketched for polypropylene's immediate future (*Chem. Eng.*, Nov. 30, 1959, p. 26). Bets on who will supply high purity propylene to Dow's proposed polypropylene plant at Torrance, Calif., can now be pretty safely placed on Richfield. And Hercules Powder has added a Lake Charles, La., location and a starting date early in 1961 to its earlier announcement of plans to build its second polypropylene plant, a 100-million lb./yr. operation.

Reports are that Richfield has received the contract from Dow and next year will build purification units to supply propylene from its Watson, Calif., refinery, although neither company cares to comment at this time.

Dow plans to start construction next year on the new polypropylene plant. It's believed that initial output will be around 10 million lb./yr., expected to climb over a five-year period to full plant capacity of about 25 million lb.

Hercules states that it has already expanded capacity of its pioneering two-year-old plant in Parlin, N. J., from 20 million to 50 million lb.

Oklahoma Gets New Industrial Landmark

Last month, Ideal Cement Co. started up the world's longest cross-country belt conveyor system. Carrying 1,000 tons/hr. crushed limestone from a quarry at Lawrence, Okla., to the mill at Ada—a distance of 5½ mi.—the new system consists of seven separate belts arranged consecutively to feed onto each other. Longest section is 2¼ mi.

As it winds its way over an "S"-shaped course, the system crosses two highways, and the Frisco and Santa Fe railroads. Construction at numerous points allows for tranverse passage of cattle and farm equipment.

Engineered, fabricated and erected by Link-Belt Co., the system represents a radical departure from conventional overland conveyors. Instead of steel, precast and prestressed concrete channel stringers support the endless rubber belts. In addition to support, the stringers form a protective cover over the moving belts.

New Coconut Oil Process Gets Commercial Tryout

Such oils as soybean, corn, peanut and cottonseed are well along in the art of continuous centrifugal processing. With short-chain lauric acid oils such as coconut, babassu and palm kernel, however, general treating practice is still the antiquated kettle method.

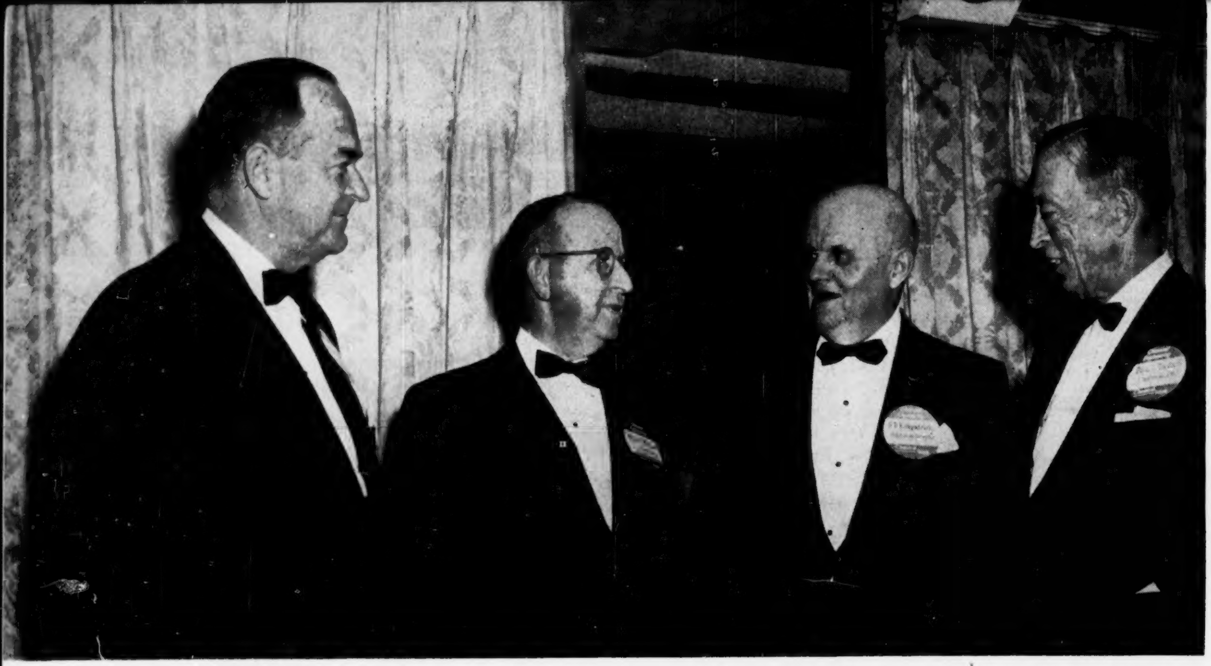
Now, a continuous centrifugal refining process has been developed for these oils.

In a paper given at the recent annual meeting of the American Oil Chemists' Society in Los Angeles, Frank Sullivan, of De Laval Separator Co., described the process which already boasts units operating in the vegetable oil industry.

To illustrate basic considerations, De Laval refers to the phase diagram of sodium laurate, electrolyte and water at 90 C. Ordinate is wt.% anhydrous soap (sodium laurate) and abscissa is wt.% electrolyte (NaOH).

De Laval found that the optimum lauric acid refining zone lay in the single-phase region of isotropic nigre phase (dark-colored layer, containing soap, salts and impurities, between layers of soap and lye). The optimum area lay between 22-37 wt.% soap and about 1-4 wt.% electrolyte. Other areas are undesirable because of high viscosity, salting-out effects or impurities remaining in oil.

Commercial process uses a completely air-free pressurized system with hermetic centrifuge. Oil and lye are separately preheated, reacted in a high-speed, short-contact mixer and immediately separated in the hermetic centrifuge. Separation in hermetic centrifuge eliminates any possible contact with air. Refined oil is water-washed, centrifugally separated again, then vacuum-dried and pumped to storage.



ACHIEVEMENT sets happy mood prior to formal presentation: l. to r., Texaco's A. C. Long, Award Chairman W. G. Whitman, Toastmaster S. D. Kirkpatrick, Food Machinery's P. L. Davies.

Winners Get First Kirkpatrick Awards

Leaders in achievement, Texaco and Food Machinery's Chemical Divisions share honors at festive presentation of first Chemical Engineering and Chemical Week Kirkpatrick Awards.

Over 1,000 leaders of government, education and industry at New York's Hotel Astor on Dec. 1 honored two chemical process companies and one man for outstanding achievement.

The companies join other illustrious winners of similar honors over the past quarter century. The man stands alone, a leader in chemical progress during 38 years of close association with the industry.

Company Honors—To Texaco, Inc. for Chemical Engineering Achievement; to Food Machinery & Chemical Corp.'s Chemical Divisions for Management Achievement.

Personal Honors — To Sid Kirkpatrick by designation of these and future Achievement Awards as the Kirkpatrick Achievement Awards.

▶ **Familiar Role**—As he had for the past 14 Award Dinners, Sid Kirkpatrick presided alternately with jest and solemnity as toastmaster of this 15th Award Dinner. Admittedly, his position could have been embarrassing, presiding at the presentation of awards bearing his name. But with innate good taste and humor, he spoofed his way around this pitfall.

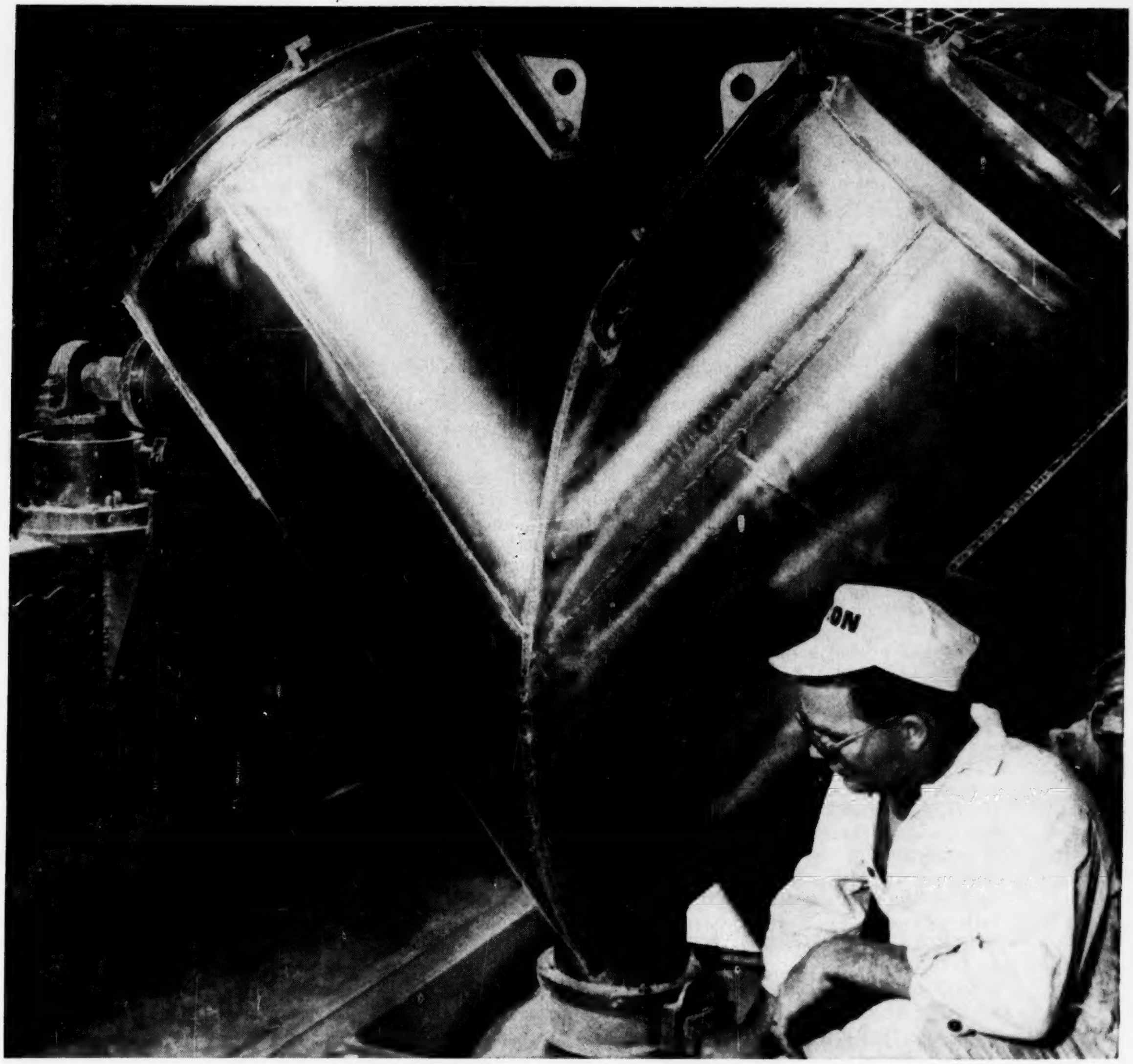
Leading off his remarks, Sid noted that the big news of the day was that in 1959 not one but two awards were being made for group effort and achievement in the chemical process industries.

▶ **Brainchild of Adversity** — Tracing the origin of the Chemical Engineering Achievement Award, sponsored by *Chemical Engineering*, Sid reminded the diners that it was born in the darkest days of a depression that sorely tried the souls of men and management:

"In those days, many a research and engineering department was being thrown overboard to keep a corporate ship afloat. But significantly, the companies that best weathered the storm were those that retained their chemical engineers and encouraged them to get out of their labs and to participate in all phases of the business recovery.

"It was to recognize chemical engineering achievements growing out of this teamwork of technology and management that *Chemical Engineering* magazine (then *Chem. & Met.*) established this unique award in 1933.

▶ **Roll of Distinction**—"The roll of distinguished corporations that have since received the



BRIGHT future is seen for U. S. engineering achievement by CE Editor C. H. Chilton and Texaco's L. C. Kemp, Jr.

Chemical Engineering Award read like the portfolio of Ferd Eberstadt's Chemical Fund. . . . If you will glance over the list of previous recipients (*Chem. Eng.*, Feb. 23, 1959, p. 76), I think you will agree that this award has played a part in the advance of chemical engineering in industry during the past quarter century.

"Texaco . . . now takes its rightful place among the leaders, having brought to commercial fruition a process (Texaco Synthesis Gas Generation Process) of outstanding worth to the chemical industry of America—in fact the whole world." (Details on Texaco's achievement are in *Chem. Eng.*, Nov. 16, 1959, pp. 175-182)

▶ **New Companion** — Continuing with his explanation of the big news for 1959—Award Number Two—Sid related, "In recent years . . . some of us have had reason to feel the need for an award that would recognize and honor the over-all achievements of corporate management—both technical and nontechnical — in the chemical process industries.

"Again we wanted to recognize group effort and team work, but along broader lines than engineering and technology. We were concerned with such things as corporate organization and growth, with financial structure and stability, with commercial chemical development and marketing, with employee, public and community relations.

"Once again we have had excellent advice, support and cooperation from a distinguished committee of representatives of education, business management and finance (*Chemical Week*, Oct. 3, 1959, p. 9). Their happy selection of Food Machinery & Chemical Corp. as the first recipient of this Chemical Management Achievement Award (sponsored by *Chemical Week*) has been roundly applauded—even by its competitors!"

Following this introduction awards were presented by Prof. Walter G. Whitman of MIT, Chairman of the Award Committees and accepted by Augustus C. Long, Chairman of the Board, Texaco, Inc., and by P. L. Davies, Chairman of the Board, Food Machinery & Chemical Corp.

▶ **Professional Recognition** — Acknowledging the award for Texaco, L. C. Kemp, Jr., Vice Pres., remarked that, "We are particularly pleased that it falls to Texaco's lot to be the first company to receive the award under its new name—the Kirkpatrick Chemical Engineering Achievement Award.

"The engineering profession is engaged in a serious effort to gain public recognition of the rightful place of its members among the learned professional groups. In his activities in the publications field and as a leader in a number of professional societies, Sid Kirkpatrick has made many important contributions to this effort as well as to the technical knowledge, professional development and economic betterment of individual engineers.

"It is, in our opinion, most appropriate that this important award in the chemical engineering field bear his name in the future."

▶ **Plan for Management**—In his remarks on behalf of Food Machinery, C. F. Prutton, Exec. Vice Pres., noted that, "Broad achievement in business can only be attained by the cooperative efforts of large groups of organized individuals with high morale."

Continuing, Prutton stated that, "Management reduced to its simpler components has three main areas of action: Planning and organization for achievement, achieving and distributing the 'spoils' of achievement.

"The first aspect of management is most significant because without adequate planning or organization, achievement in the modern business world is almost an impossibility."

▶ **New Flexibility**—Dealing with building an organization, Prutton said that, "In an organization geared for today's rapidly changing business, one must develop great flexibility in his men. These men must be thoroughly indoctrinated to constantly expect and aggressively meet rapidly changing conditions.

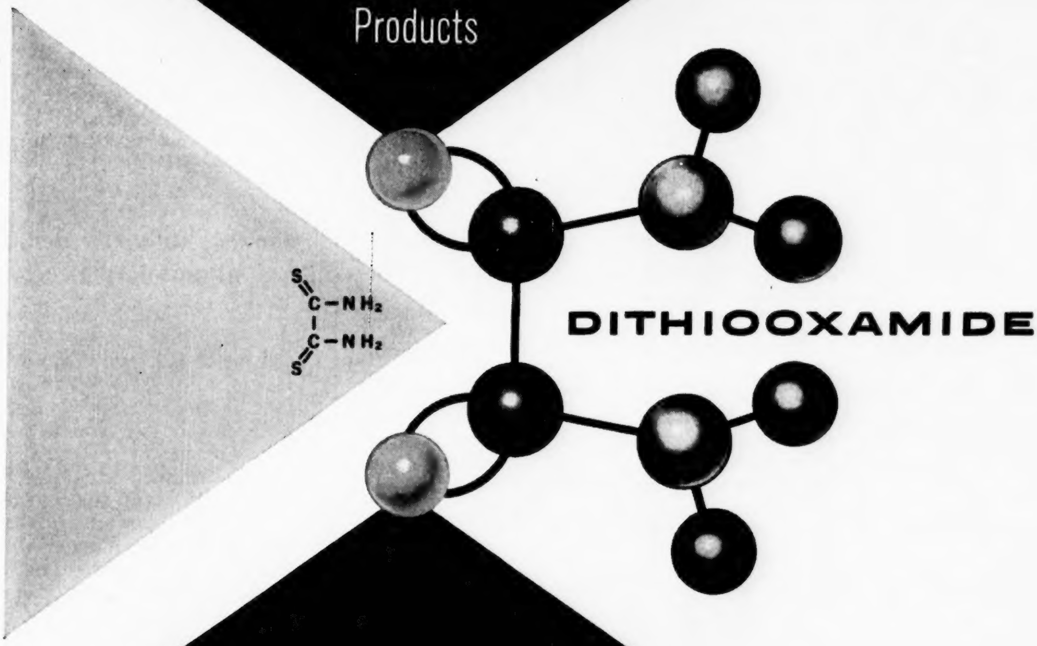
"If proper planning and organization for achievement are made, the task of achievement will follow smoothly. Through proper planning, achievement can be carried out by highly trained subordinates properly selected and trained during the organization stage.

"The distribution of 'spoils' is also an area that many executives appear to neglect or dispose of as expeditiously as possible, or handle on the spur of the moment. The thought given to this area should equal that of planning, for future planning and achievement depend on the organization's men to whom most of the 'spoils' should be distributed."

▶ **The Clincher**—To clinch the importance of achievement, T. Keith Glennan delivered a keynote speech on "Framework for Achievement—1959." On leave as President of Case Institute of Technology and currently Administrator, National Aeronautics and Space Administration, Dr. Glennan discussed the interrelation of industry, government and education to contribute to progress for everyone.

Processes & Technology continues on page 32.

SULPHUR
helps to create Headline Products



Mallinckrodt Chemical Works, St. Louis, Missouri, recently announced this new building block...a chemical that can go in many directions to create new and better products. For example, the manufacturer suggests applications for dithiooxamide and its derivatives in the fields of metal sequestrants, pigments, organic intermediates and plant growth regulators.

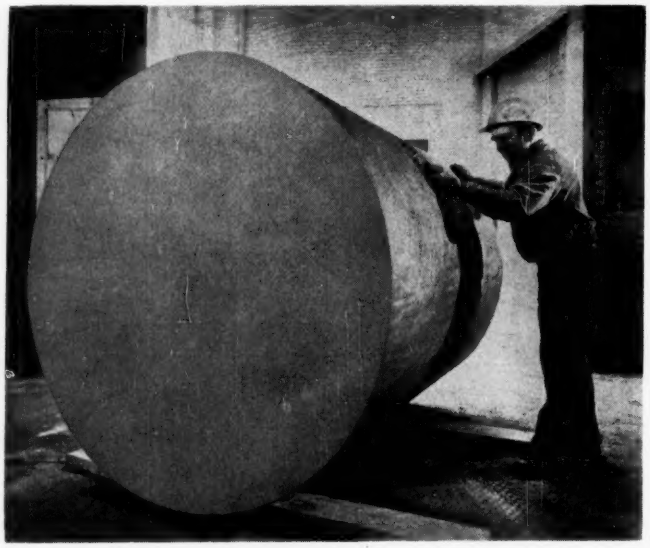
A new building block with many potentials ...and as with so many such chemicals, Sulphur is a key ingredient!

Our business is to produce Sulphur ...to keep adequate supplies on hand at our production units...to deliver it in solid form by rail, barge or ship; in molten form in trucks, tank cars, barges, or ships. All of the properties listed below can supply both solid and molten Sulphur.

TEXAS GULF SULPHUR COMPANY

75 East 45th St., New York 17, N. Y.
811 Rusk Ave., Houston 2, Texas

Sulphur Producing Units: Newgulf, Texas • Spindletop, Texas • Moss Bluff, Texas • Fannett, Texas • Worland, Wyoming • Okotoks, Alberta, Canada



Solid State Is Prerequisite for Graphite Column

This 7-ton, 61-in. dia. by 72-in. long graphite cylinder, the biggest ever made, will become part of a large graphite tower. Starting with fine-grained graphite in this unprecedented size, National Carbon Co. cores the cylinder to make a section for tower where elemental phosphorous will be burned for production of phosphoric acid. Cylinder resembles giant graphite furnace electrodes (Chem. Eng., Apr. 7, 1958, pp. 128-131).

More Horsepower Per Pound of Gas Turbine

Latest breakthrough in regenerative gas-turbine design is a 75-lb. machine that cranks out a hefty 75 hp. at the shaft. Described as "breadbox size," the unit, developed by Williams Research Corp. (Walled Lake, Mich.), will feed on fuels ranging from kerosene to highly leaded gasolines.

Contributory to the bonus horsepower-to-weight ratio is extensive use of aluminum die castings for the turbine's rotating parts. Moreover, by eliminating components necessary to regenerative operation, the firm claims it can knock off another 25 lb. over-all weight. Such nonregenerative versions are foreseen for certain military applications, such as lightweight helicopters.

Williams has already licensed a number of manufacturers to produce the powerplant for on-the-ground purposes. These units will normally turn over at 58,500 rpm., delivering shaft power at 5,000 rpm.

New Ceramic Rivals Metal At High Temperatures

A new ceramic material that boasts thermal-shock resistance as good as metals at temperatures around 1,200 C. has been developed by the United Kingdom's Admiralty Materials Lab. It also offers good creep strength, oxidation, electrical and chemical resistance.

Described as silicon nitride stiffened with a 5% dispersion of silicon carbide, the new material was developed primarily for use in gas turbine stators. But now the British lab predicts that the ceramic will find jobs as electrical insulators on rocket launching pads, support for high-temperature catalysts, thermocouple sheaths and in a wide range of structural uses such as in high-temperature furnaces.

Reason: Material withstands 50 cycles of rapid heating to 1,200 C. before showing any signs of cracking. Moreover, it has a Young's modulus value of 4,000 psi. and a thermal expansion coefficient of 2.5×10^{-6}/deg. C. throughout that temperature range.

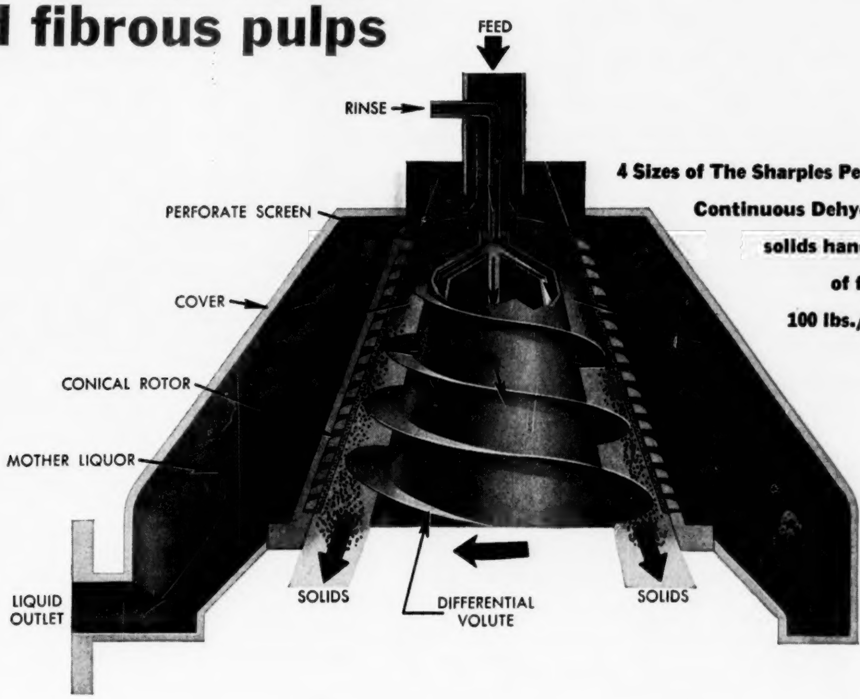
Nuclear Industry Meets In Nation's Capitol

Technical and management people of the nuclear industry converged last month on Washington, D. C., for a joint national meeting of the American Nuclear Society and the Atomic Industrial Forum.

Rich technical content of ANS papers spiced up managements' long-range planning and evaluation and led to some solid controversy and speculation. Seriously in question was the need for breeding in the face of present uranium reserves and nuclear-fuel consumption. Several industry representatives disclaimed the need for breeding within the next 30 years while some even disclaimed the need for breeding at all. Other industry and AEC spokesmen pointed out the need for developing technology now, for even the unforeseen future. Herein lies the motive for construction of the Fermi Fast Breeder and the recent creation of the thermal-breeder development program.

In the field of radiation processing, we noted with interest that chemonuclear reactors sneaked into the program in more than one place. Strictly paper calculations claim that a spare loop, to carry radioactive reactor coolant outside a nuclear reactor, may lead to radiation processing costs as low as 7.5 ¢/kwh. Calculation was based on an Atomics International or-

flexibility for deliquefying crystalline solids and fibrous pulps



4 Sizes of The Sharples Perforate Screen Continuous Dehydrator provide solids handling capacity of from less than 100 lbs./hr. to 70 tons or more/hr.

THERE ARE WIDELY DIFFERENT BENEFITS to be derived from the Sharples Continuous Dehydrator, depending on the product.

Dewatering high concentration sodium chloride and potash . . . processing starch or other fruit and vegetable products containing fibrous solids . . . deliquefication of organic crystals that must not be changed in size or shape . . . each of these typical yet widely different applications makes use of the fact that the Continuous Dehydrator combines the *separating action* of high centrifugal force, the *filtering action* of the replaceable screen, and the *metering action* of the differential volute.

This combination of forces applied to certain slurries is ideal. The ability to change screen size and vary rotational speed as desired, and the gentle, controlled action of the differential volute are additional advantages for processing flexibility.

THE SHARPLES CONTINUOUS DEHYDRATOR, available in four sizes, including the Model 510 with solids handling capacity of 70 tons per hour or more, supplements the well-known line of Sharples Centrifuges for deliquefying solids.

Write today for literature about the advanced design Sharples Continuous Dehydrator.

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ganic-cooled reactor. Brookhaven National Laboratory reports even more optimistic figures for its dust-fueled reactor.

These but exemplify the acute attention nuclear know-how is getting these days. Managements realize that continuation of the nuclear industry depends on the technical achievement of economic nuclear power within the next ten years or so. Euratom's chairman, Etienne Hirsh, reveals his recognition of this by promoting the construction of prototype power reactors of various types in Europe to assure achievement of this know-how. Attendees of both national meetings clearly recognize that the years immediately ahead will be years of technical effort, rather than years of newspaper headlines.

Iron-Curtain Nations Up CPI Activity

With a mighty surge toward increased chemical industry activity and stature, Iron Curtain countries are breaking through boundaries on production statistics and the geographical variety.

• In Mexico, reports are that Russia's Mikoyan—there to inaugurate the recent Russian Exposition—has made Pemex an offer to construct an entire "petrochemical city." Machinery, technical design, etc., would all be Russian with payments coming on an extra-long-term basis. A few days before, Pemex had received Mexican Government authorization and funds to spend $112 million exclusively in the petrochemicals field.

• In Poland, an agreement has just been signed between the foreign trade centers Polimex, Textilimport and the English firm, Imperial Chemical Industries. The agreement involves purchase by Polimex of production technology and a license for construction in Poland of a polyester fiber plant. Fiber will be imported from ICI in England by Textilimport until the Polish plant is completed in 1963.

• In chemical plant expansion, U.S.S.R. has announced that the average speed of new plant commissioning will be one unit built or overhauled every ten days. Investment in the chemical industry will be jacked up 30% in 1960. Expenditure of 105 billion rubles/yr. is planned which, at the official exchange rate, is $26 billion, or twice the planned U.S. investment.

• In Russia, equipment production has reached a value of 1.2 billion rubles by the end of 1959's third quarter, 49% more than output value in a corresponding period in 1958.

• In chemical products, Russia's chemical and rubber industry had increased output by 10% after the first nine months of 1959. Synthetic fiber production was up 8% to 131,000 tons and sulfuric acid output jumped 6% to 3.7 million tons. Although production figures were not released, caustic soda, soda ash, synthetic ammonia, synthetic resins and plastics all fulfilled or exceeded expected quotas. Synthetic resins and plastics were up 14%, cellulose ethers up 12%, PVC resin and copolymers up 18%, synthetic ethyl spirits up 47% and synthetic fatty acids up 59%.

Solar Energy Converters Set for Space Travel

World's first plant for mass production of solar-energy converters was opened last month by Hoffman Electronics Corp. at El Monte, Calif.

Demonstration of "Big Bertha," claimed to be the world's largest solar-energy converter, highlighted the plant's opening. Giant device consists of 7,800 silicon semiconductor cells, mounted on an 8-ft. by 4-ft. panel. To maximize the unit's efficiency, the face of the panel turns on its swivel base to follow the sun. And electrical energy, not expended as it's generated, stores in batteries when moons, planets or clouds veil the sun's rays.

U. S. space-probe administrators focus much attention of late on solar-energy converters as an excellent space vehicle auxiliary-power source; success of our paddle-wheel satelite affirms their practicality.

Hoffman's new plant is equipped to produce semiconductors to meet tight space-application specifications. Computer console will check electrical output per unit of light input for semiconductor crystals, coming off the production line. And completely automatic furnace for single-crystal growth will assure consistent quality.

NEWS BRIEFS

Aluminum plating: Allis-Chalmers Research Labs has come up with a much-simplified technique for silver coating aluminum bus bars, simpler even, it's claimed, than coating those bus bars with copper. Whereas silver-coating aluminum is usually an eight-step process, A-C's new process takes only three steps —an alkaline dip, a new type of mercuric-compound bath and the silver plating itself. Process cuts plating time, reduces silver metal requirements and needs less skilled personnel to operate.

Infrared analysis: Infrared analysis, widely used for organic liquids, is beginning to catch on for use on inorganic solids. Advantages over usual solid analysis techniques: IR gets representative readings with small samples, is fast and provides a permanent record. Kennecott researchers predict IR will find wide use in glass, clay, ceramic, cement and lime industries, as well as for analyzing pigments in paints. Another possibility: bauxite analysis, now requiring a costly, time-consuming caustic digestion without guarantee of accurate results.

Steel: Russians claim to have developed a process by which steel can be fabricated to resist the "fantastic" loads of nearly 2 million psi. Soviet scientists report that process "succeeds in moving atoms of matter so close together" that virtually no space exists between them.

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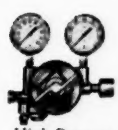
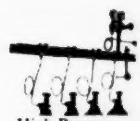


High Pressure Gas Regulators



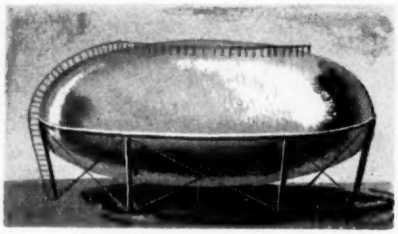
High Pressure Gas Cylinder Manifolds

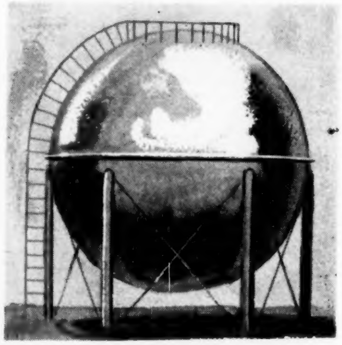
Plant expansion

◂ 1957 Towering optimism

▾ 1958-59 Squelching cutbacks

1960 Realistic building ▾





Chemical Spending: Upturn in 1960

Record chemical sales this year trimmed most of the fat from 1958's unwieldy excess capacity. Prudent new-plant spending will keep it well proportioned.

Alfred Litwak, McGraw-Hill Dept. of Economics

Capital spending in the chemical process industries (CPI)—which rose to giddy heights in 1957, was clobbered by the 1958 recession, and failed to snap back this year—is preparing to take off again before once-swollen capacity gets too thin for comfort.

The annual McGraw-Hill survey of business' preliminary plans for capital expenditures indicates that CPI firms now plan to spend a rousing 21% more for new plant and equipment in 1960 than in 1959. In some of the chemical process industries—paper, rubber, and stone, clay and glass—plans call for a record level of capital expenditures next year.

▸ **Everybody Up**—The upturn in capital spending by companies in the CPI group is in line with the trend for business in general. Preliminary plans for all business call for capital spending in 1960 that is 10% higher than the estimated total for 1959.

Manufacturers plan to increase capital outlays by 19% next year,

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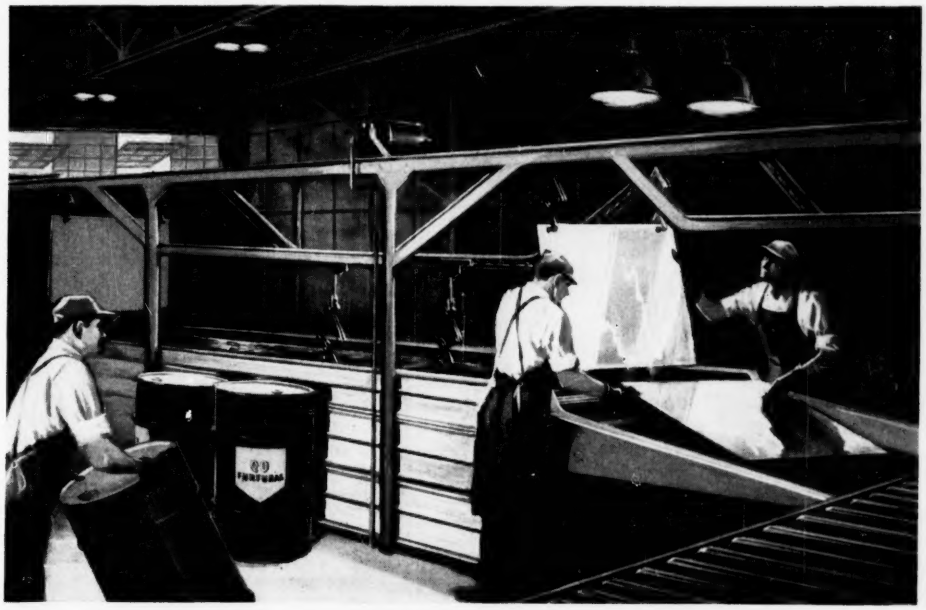
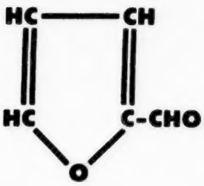


QO® FURFURAL ADDS "BITE" TO PAINT AND VARNISH STRIPPERS



Excellent solvent properties plus low volatility, good wetting action and low toxicity make QO furfural a superb stripper ingredient. Solvents combined with QO furfural are reported to have more "bite" than when used alone.

Because of its low volatility, a furfural type finish remover requires little or no evaporation retardant and cutting power of the solvents is not reduced. No oily residue need remain on the stripped surface; furfural washes off with water.

QO furfural formulations are currently used in industrial stripping solutions. These products are effective in removing a variety of finishes including oleoresinous varnishes and baked alkyd coatings.

Other Facets of Furfural

The benefits provided by QO furfural in stripping operations represent only one area of application. Versatile furfural also delivers benefits as a chemical intermediate, reactive solvent, selective solvent and phenolic resin modifier. Put the "bite" on QO furfural for help with your product or process development. Write for information indicating your field of interest.

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Chemical Processors Loosen Their Pursestrings Again

	Capital Spending, Million Dollars				
	1957	1958	1959	1960	1961
Chemicals	1,724	1,320	1,188	1,473	1,502
Petroleum refining	853	665	692	754	814
Pulp & paper	811	578	613	828	704
Rubber	200	134	178	233	247
Stone, clay & glass	572	399	542	603	594
All CPI	4,160	3,096	3,213	3,891	3,861
All manufacturing	13,647	9,761	10,025	11,957	11,171

compared with 1959. Total dollar spending for new plant and equipment by all business in 1960 may approach the record level of 1957.

▶ **Steel-Strike Concern** — The survey was completed in October, and thus represents industry thinking at a time when the full impact of the steel strike was being felt. Because of the strike, capital expenditures by some industries were deferred, and total capital spending by all business for 1959 will fall below levels planned earlier this year.

Estimated total capital expenditures by the chemical industry for 1959 dipped substantially below the planned level reported to McGraw-Hill several months ago, and are also below actual expenditures for 1958.

Capital spending by steel and other industries directly affected by the strike similarly was cut back. The latest survey clearly indicates, however, that the dip in capital expenditures was only temporary. Capital spending affected by the steel strike was postponed, not canceled, and will be carried over into 1960.

▶ **Chemical Bounce** — Capital spending by the chemical industry will bounce back sharply next year. Preliminary plans reported in the McGraw-Hill fall survey call for expenditures of almost \$1.5 billion by the chemical industry alone in 1960.

And chemical companies already have plans for even greater capital outlays in 1961. Capital spending planned for 1960 is a whopping 24% above estimated expenditures for this year (although it is still below the record level of 1957).

Capital expenditures now planned for 1960 by other companies in the CPI group similarly show impressive increases over this year's levels.

Paper and pulp companies plan to increase capital expenditures by 35% in 1960. Total capital expenditures by companies in this industry will amount to \$828 million next year, according to present plans. That amount represents a new dollar high for capital spending in this industry.

Capital spending by the petroleum refining industry will be up 9% next year, compared with 1959. Companies in this industry now anticipate further increases in capital expenditures for 1961.

In the rubber industry, spending for new plant and equipment in 1960 will jump 31% above the level for the current year. In this industry, too, capital spending slated for 1961 is greater than expenditures now planned for 1960.

In the stone clay and glass group, capital expenditures next year will be 11% higher than for 1959. And spending now planned for 1961 is only slightly below the level anticipated for 1960.

▶ **Expand and Modernize**—Last spring, most manufacturing companies reported that expenditures then anticipated for the 1960-62 period would be primarily for modernization of obsolete facilities rather than for plant expansion. Chemical industries, however, reported that almost two-thirds of their capital expenditures during 1960-62 would be for plant expansion.

It is possible that high operating rates and good sales prospects in many industries have led to a revision of earlier plans, resulting in a greater emphasis on plant expansion than previously anticipated. Modernization will, nevertheless, get a substantial share of next year's capital spending.

And increases in capital expenditures planned for 1960 are based on optimistic sales forecasts. Sales volume of the CPI group is expected to rise by 7% in 1960. Gains expected range from a 9% increase anticipated for the chemical industry, to 3% for oil refining. Steel and other durable goods industries whose 1959 sales were cut by the steel strike will, of course, show more impressive gains. For all manufacturing, sales volume for 1960 is, therefore, expected to be 9% above this year's level.

▶ **Funds From Within**—The survey also provides definite indications that tight money won't have much effect on business' spending for 1960. Companies reporting their financing plans in this survey indicate that most of the funds needed to finance next year's capital expenditures will come from internal sources—retained earnings and depletion or depreciation allowances.

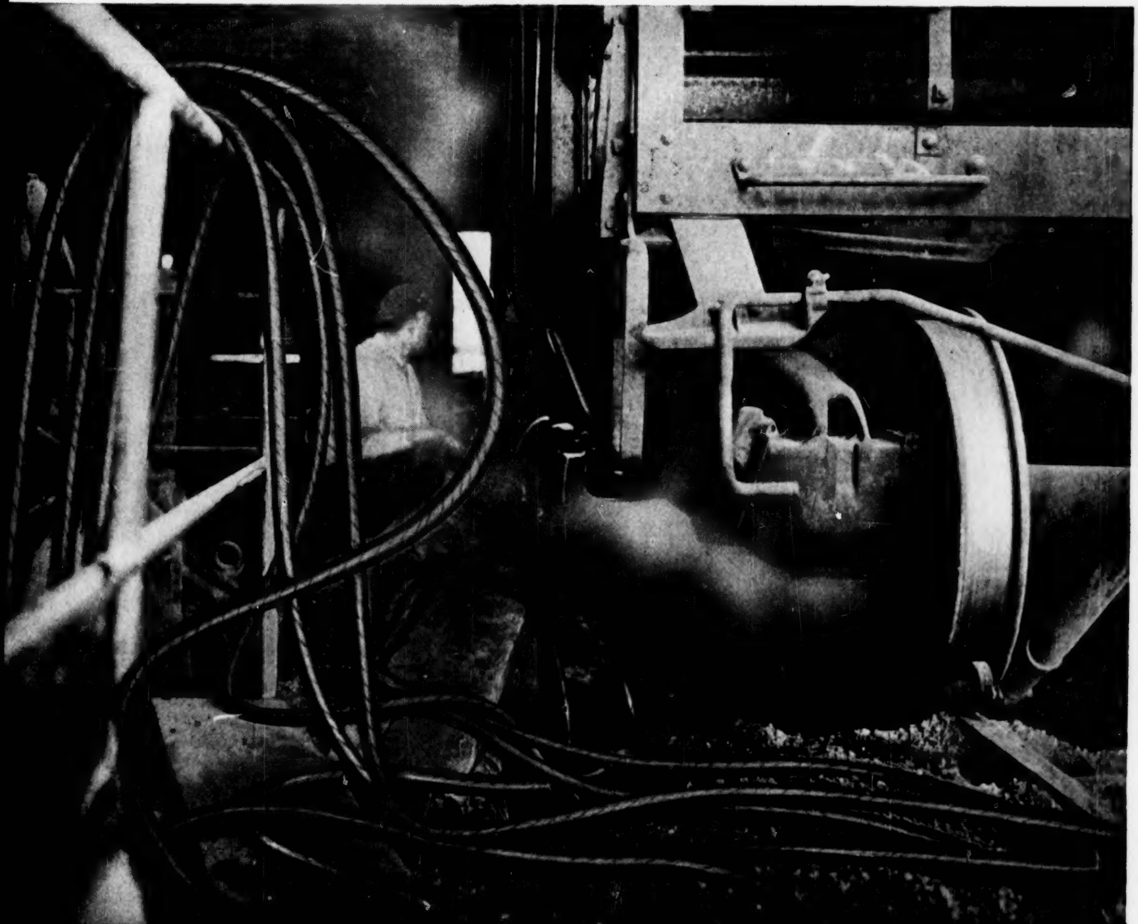
Manufacturing companies, including the CPI group, expect to finance only about 7% of next year's capital expenditures through borrowing. Most companies thus should be able to carry out planned spending unhampered by tight money.

In 1960, then, many industries will make important progress, in the campaign against technical obsolescence, through modernization of plant and equipment. And substantial additional capacity will be provided to meet the growing volume of business.

Latest on Capital Goods

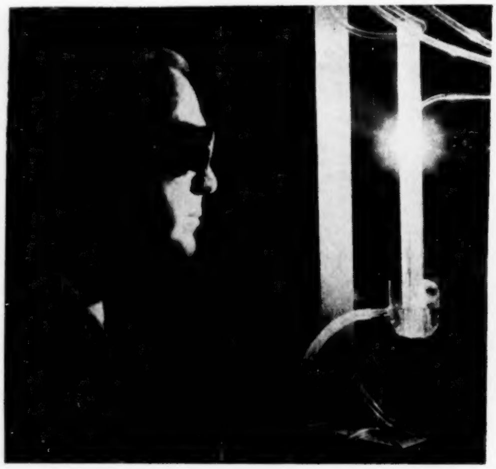
McGraw-Hill's latest forecast of machinery orders says an 8% slip in 1959's last quarter will be offset by a 5% gain in the first quarter this year and 6% hikes in each of the next two quarters.

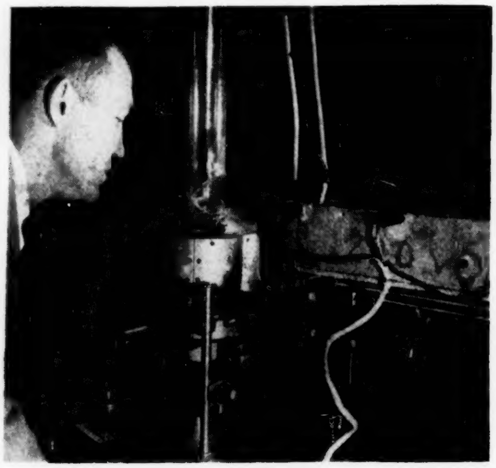
Pump and compressor orders will soar 30% higher in July-Sept. this year than in a like period in 1959; engines and turbines will rise 25%.



CHEMICAL PRODUCTS EDITED BY FRANCES ARNE

Zone Melting Route to Larger and Purer Crystals





Larger Boron Crystals

Boron powder can now be floating zone melted (left, above) thanks to a new method for pressing rods of commercially available powdered boron.

Boron ordinarily does not lend itself to floating zone melting because pressed forms are so friable they crumble on removal from forming dies.

By a new technique boron powder is placed in boiling boric acid solution and the mixture boiled to dryness. This coats the boron granules with boric acid, and the powder can then be pressed into forms, handlable without breaking. Formed bars are heated under vacuum to decompose the boric acid into boron oxide. This compound forms a liquid coating which hardens on the boron particles, and bonds the powder into a strong bar.—Bell Telephone Laboratories, New York. 40A

Purer Indium Antimonide Crystals

The pendant-shaped indium antimonide crystal suspended in the glass, right above, represents the purest crystal ever made of any compound. To be used in low-temperature transistors, it has a purity of 99.999999+ obtained through the use of unique equipment developed at Battelle.

Without removal from the apparatus pictured, the indium antimonide was first zone refined in the horizontal quartz tube, then poured into the furnace crucible, after which the crystal was pulled in the vertical glass column.

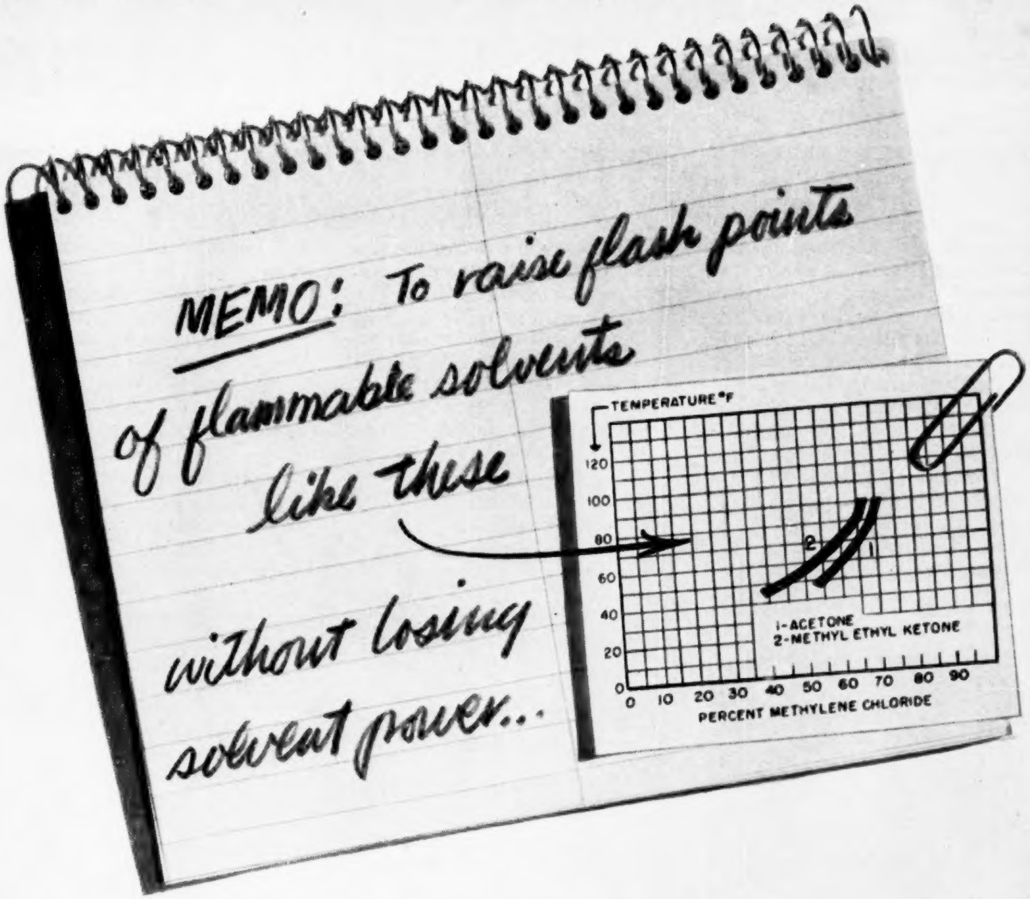
The crystals are being used to study basic properties of the material for the Air Force Office of Scientific Research and to investigate uses of indium antimonide in galvanomagnetic devices. — Battelle Memorial Institute, Columbus, Ohio. 40B

Gasoline Additive

Provides excellent detergency and anti-icing.

A new gasoline additive identified as a modified phosphatide has been announced. Engine research, road tests and commercial usage by a major refiner show that the product provides excellent carburetor detergency and anti-icing, plus serving as a mild rust inhibitor. Data show that the product does not contribute to intake valve deposits, ORI, surface ignition, spark plug fouling, sludge or varnish formation, or cause any other detrimental side effects.

About 25¢ worth of the new product treats enough gasoline for over 20,000 mi. of average driving, saves as much as $25 in service expense, promotes maximum efficiency of carburetor operation, and provides the anti-icing properties. At a suggested concentration of 50 ppm., the product prevents and gradu-



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ally removes deposits on the carburetor throat and throttle plate. This use level also provides icing protection for highly volatile gasolines through an unusual synergy with phosphorus additives.

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Centrol S-41-K is said to be easy to handle, completely soluble in gasoline and other hydrocarbons, and compatible with other kinds of gasoline additives.—**Central Soya Co., Fort Wayne, Ind.** 40C

Epoxy Resin

New market in plastic-and-grit "cookies" to give bridge grates traction.

To prevent skidding on the steel roadbeds of bridges, Shell Chemical has developed a plastic and grit mixture that is applied in cookie-like blobs.

Based on the company's Epon resins, an epoxy adhesive material, the cookies are said to bond to the steel cross points with about the strength of a weld. The grit in the mixture, usually emery, gives cars extra traction.

The cookies are being tested on three bridges, two in California and one in Washington, D. C. Applied in 1957 to the twin spans of the Park and Hyde Street bridge, between Oakland and Alameda, Calif., the cookies have reduced skidding accidents from a high of 35 per year down to zero.

Company has also developed a new low-cost epoxy resin-bitumin coating especially suited for use as an economical corrosion-resistant coating for pipe and other metal equipment and on concrete surfaces.

Based on Epon 828 and Bitumen C, a compatibilized bitumen which Shell will market, it has greater chemical resistance than existing epoxy-coal tar enamels. Two-month immersion tests showed it to be unaffected by many acids and other corrosive materials. It is suggested for use on the inside and outside of pipe, on offshore drilling rigs and for service in any area subject to corrosive chemical fumes and spillage.—**Shell Chemical Corp., N. Y.** 42A

Diphenolic Acid

Basis for a new water solution coating.

Technically unique properties of DPA, Johnson's brand of 4,4-bis (4-hydroxyphenyl) pentanoic acid, have been announced. Findings concern the development of a water-solution coating system incorporating diphenolic acid and the formulation of a derivative, Polyether Acid N-1, as a useful new ingredient for alkyd resins.

The new water-base coating system provides a bake finish and uses water as the sole solvent. It is applicable as a primer on all metals. Advantages cited for the new coating include a curing time of only 20 min. at 250 F. The films show excellent resistance to water, salt spray and detergents. No adverse effect from water immersion is apparent after 96 hr. A 5% salt fog for 200 hr. exposure produces less than 1/32 rust creepage.

Other characteristics include good adhesion to unprimed surfaces and the films, when properly pigmented, provide a smooth glossy finish. These properties plus the basic advantages of water-solution coating systems, should offer unique opportunities in the development of new industrial finishes.

Small ratios of Polyether Acid N-1, a DPA derivative, have been found to have favorable effects when formulated with alkyd resins. Great improvement in air dry speed is noted. There is a marked increase in viscosity without a tendency to gel, making possible either lower phthalic content at equal viscosity, or lower alkyd content at equal viscosity in finished paints. Marked improvement is apparent in gloss reten-

Newsworthy Chemicals

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➡ *Joy Design* Means:

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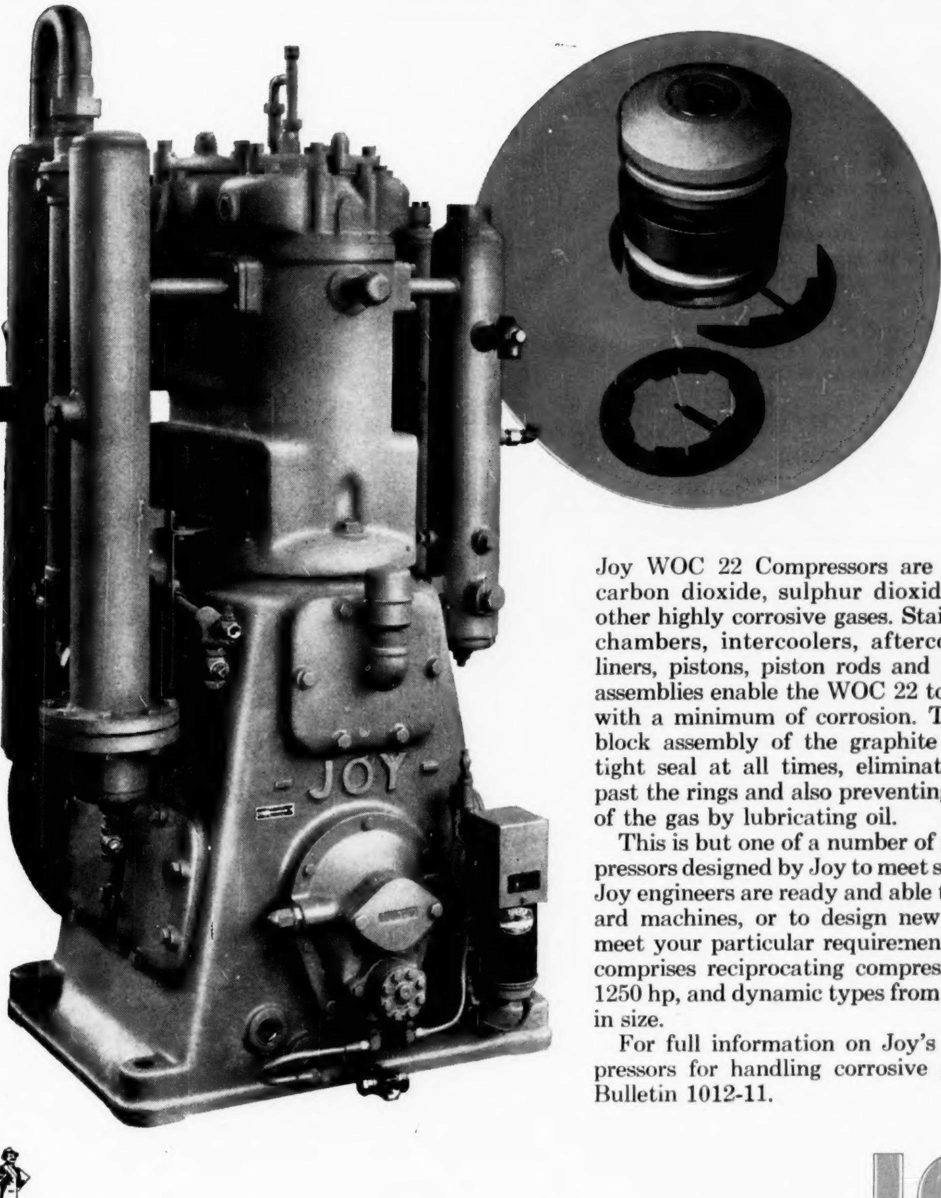

Joy WOC 22 Compressors are built to handle carbon dioxide, sulphur dioxide, chlorine and other highly corrosive gases. Stainless steel surge chambers, intercoolers, aftercoolers, cylinder liners, pistons, piston rods and inlet and outlet assemblies enable the WOC 22 to compress gases with a minimum of corrosion. The exclusive T-block assembly of the graphite rings assures a tight seal at all times, eliminating gas leakage past the rings and also preventing contamination of the gas by lubricating oil.

This is but one of a number of specialized compressors designed by Joy to meet special problems. Joy engineers are ready and able to modify standard machines, or to design new compressors to meet your particular requirements. The Joy line comprises reciprocating compressors from 15 to 1250 hp, and dynamic types from 15 to 15,000 hp. in size.

For full information on Joy's WOC 22 Compressors for handling corrosive gases, write for Bulletin 1012-11.

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tion on exposure and there is no alteration of the color retention qualities of the alkyd.

Polyether Acid N-1 is suitable for use in most types of alkyd processing and practical to use in both isophthalic alkyds and in orthophthalic anhydride alkyds.

The new derivative is made from the reaction of dichloroethylether and DPA. N-1 has a reactive functionality of four. The carboxyl groups react with the polyhydric alcohols normally used in alkyd resin formulation. The hydroxyl groups react with the acid ingredients used in alkyd resins. Since Polyether Acid N-1 contains acid and alcohol groups in equal ratio, the addition of this new ingredient does not alter the acid-to-hydroxyl value in previously established alkyd resin formulations.—**S. C. Johnson & Son, Racine, Wis.** 42B

Epoxy Resin

Bonds with a polar or a porous surface.

Kopoxite 159 is a liquid epoxy resin composed primarily of resorcinol diglycidyl ether. Two epoxy groups in a small aromatic molecule, it offers the highest epoxy concentration available in an aromatic diepoxide.

Low viscosity and a high order of reactivity with both amine and acid anhydride curing systems permits a wide selection of curing conditions. Now available in development quantities, Kopoxite 159 used in adhesive formulations will bond with almost any material presenting a polar or porous surface.

Properties

Oxirane oxygen (ox-ox) content, wt. %	12.5
Total chlorides, wt. %	0.5
Free epichlorohydrin, wt. %	<0.1
Ionic chlorides	nil
Moisture, wt. %	0.3
Color (straw yellow)	Gardner 5
S.G. @ 25 C	1.21
Lb./gal. @ 25 C	10.1
B. P. @ 0.8 mm. Hg, C	172
Viscosity @ 25 C., cp	500
Refractive index n_D^{25}	1.541

Product's outstanding characteristics, in addition to the normal properties of unmodified liquid epoxies, make Kopoxite 159 particularly useful as a principal component of castings, potting and encapsulating compounds, tooling compounds, laminates, and adhesive. In addition, it is compatible with a wide variety of solvents and resins which further suggests its usefulness as a reactive modifier for surface coatings.—**Koppers Co., Pittsburgh, Pa.** 44A

Cemented Carbide

Makes ball point pen skip free.

What might appear to be hundreds of tiny pebbles is in fact a photomicrograph of a tiny area on a 1-mm. cemented carbide (Carboloy) ballpoint magnified several hundred times. The picture points up the lasting nonskid or textured surface which gives the ballpoint greater gripping action than obtainable with other ballpoint materials such as stainless steel or artificial sapphire.

Developed after years of research by GE's metallurgical products department, the new ball is produced from the hardest metal made by man, Carboloy carbide. This means that the nonskid surface of this point prevents skipping on damp or greasy surfaces, and is never worn down by usage during the life of the pen.—**General Electric Co., Detroit.** 44B

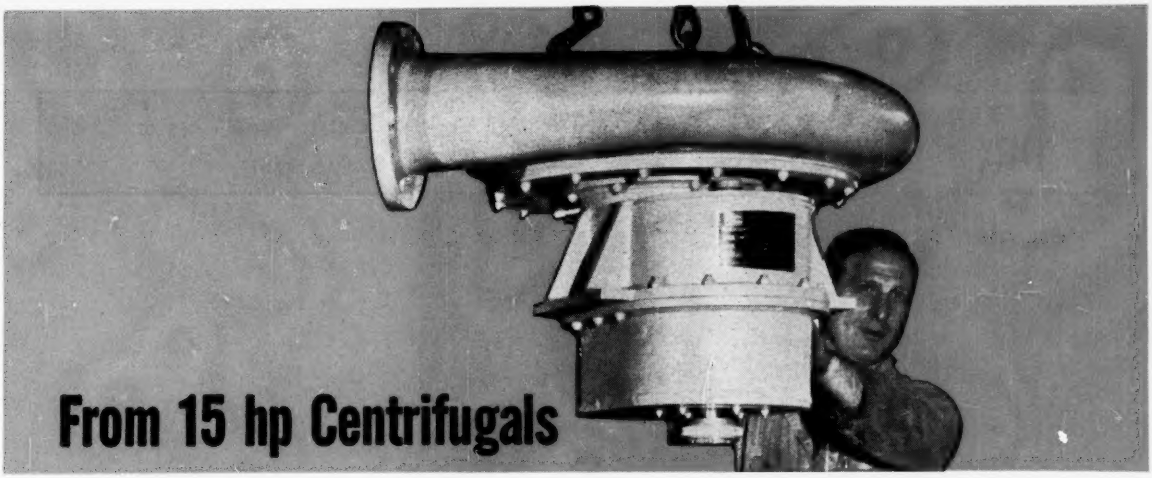
For More Information about any item in this department, circle its code number on the **Reader Service** postcard (p. 137)

BRIEFS

Fire-resistant polyurethane rigid foams with low K factor are produced by a new alkyd resin system utilizing trichlorofluoromethane as foaming agent. Hetrofoam 16 is the resin used and Hetrofoam 17, the semi-prepolymer. The system is suitable for processing in continuous mixing and metering machines or in batch mixing equipment. — **Hooker Chemical Corp., Niagara Falls, N. Y.** 44C

Non-skid ink for corrugated containers has been introduced. Tradenamed Non-Skid-Speed-Glo, the new ink has longer lasting adhesive qualities which help hold together pallet loads of carboard containers. Company declines to identify composition but says the ink doesn't stick like an adhesive but does prevent skidding.—**California Ink Co., San Francisco.** 44D

Decay-killing gas released by impregnated paper may protect oranges during shipment. The impregnated sheets release a decay-killing gas, a compound of active chlorine and nitrogen. Active ingredient in the gas is sodium dichloroisocyanurate. First it is impregnated on paper sheets from solution, then dried. Two sheets are placed in each orange carton, between top and bottom layers of fruit. Humidity produced by fruit causes chemical to decompose and give off fungicidal gas. Gas surrounds the fruit with a protective atmosphere, but apparently without entering the fruit. However, more development work is needed before industry trials. —**University of California, Riverside, Calif.** 44E



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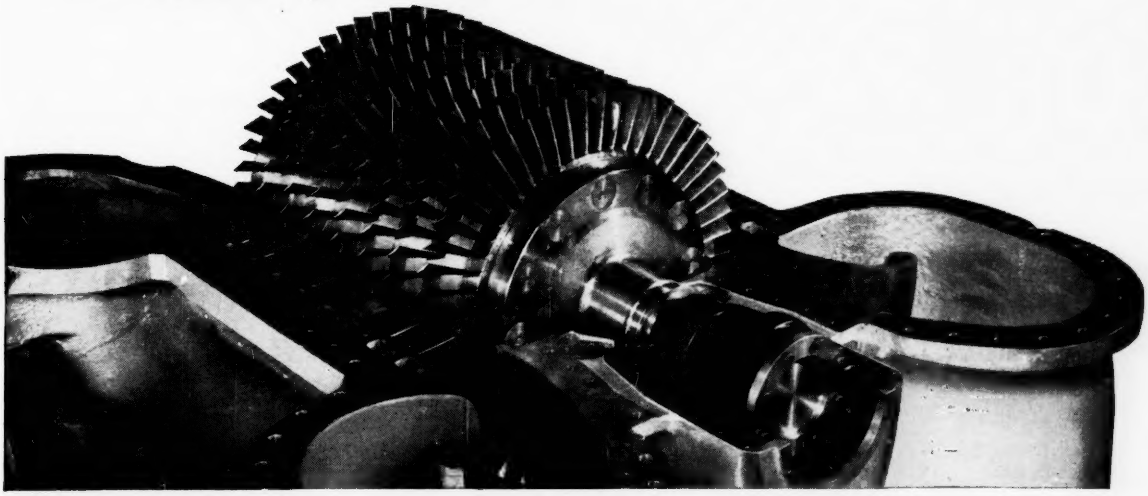
to 15,000 hp Axials...



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Joy can supply a compressor with the exact performance characteristics and physical configuration to meet your requirements, no matter how large or how small. Standard models are available, or Joy Turbodynamics engineers can design to your specifications in any size of compressor—either centrifugal or axial-flow types.

Compactness and efficiency are achieved in all Joy dynamic compressors through high stage performance. Advanced aerodynamic concepts and modern metallurgy have contributed to designs which provide the maximum of compressed air or gas for power consumed and floor space occupied.

Joy Axial-flow and Centrifugal Compressors will prove the most economical solution, whether you are compressing plant air, or process air or gas, at normal or elevated pressures and temperatures. If you have an air or gas compressing problem, check with your Joy representative or write for our bulletin "Joy Turbodynamics."

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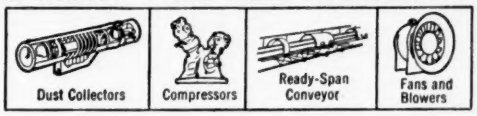


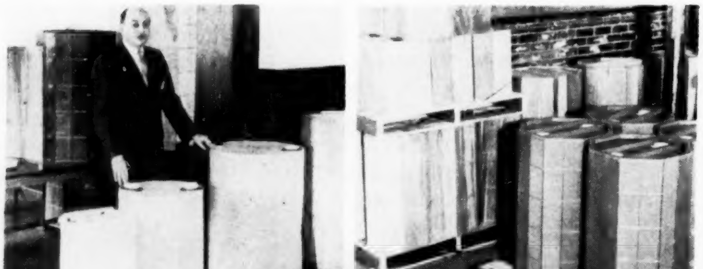
JOY

Joy Manufacturing Company
Oliver Building, Pittsburgh 22, Pa.

In Canada: Joy Manufacturing Company (Canada) Limited, Galt, Ontario

WIREBOUND-WOOD overwraps plus rigid polyethylene drums combine to make new liquid containers.

New Shipping Drum: Wood Over Plastic



SIZES now available are 5, 15, 30 and 55 gal. A 250-gal. composite package is in works. All sizes lend themselves well to palletization.

Composite liquid pack boasts light weight, low cost and high durability.

Steel overpacks for plastic shipping drums may be on the way out. At least that was the opinion expressed by Delaware Barrel & Drum Co. at last month's unveiling of its new returnable family of composite liquid containers.

Offered in four common sizes, the new packages consist of an inner polyethylene drum protected by a wirebound-wood overwrap.

Specifications of the rigid poly-

UNION STAINLESS STEEL

Fight corrosion with this lineup

UNIONWELD
Pipe

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Pipe & Tubing

UNIONSEAMLESS
Pipe & Tubing

UNION 20-S
Pipe, Tubing, Strip, Sheet, Plate, Bar

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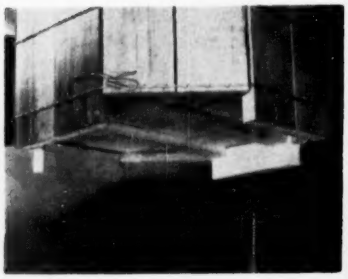
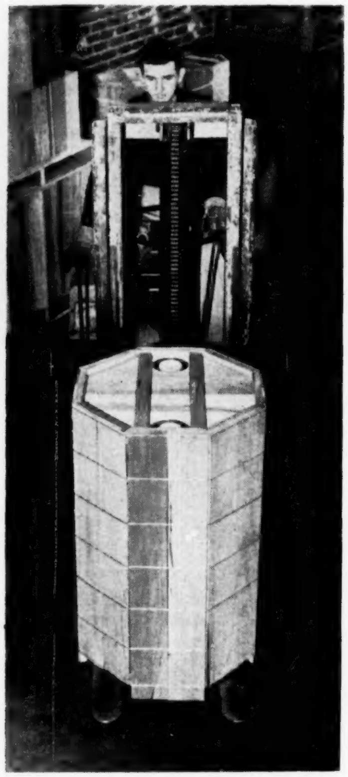


UNIQUE feature of the 55-gal. container is a built-in pallet base that affords easy handling with conventional fork lift trucks.



ethylene inserts, as manufactured by DB&B, are unchanged from those currently being used inside steel drums. The outer shells, designed by Package Research Laboratory (Rockaway, N. J.), consist of wooden slats reinforced with galvanized steel binding wires and staples.

Overwrap shape for the 15-, 30- and 55-gal. sizes is octagonal. Floor-space requirements for these are approximately the same as for steel drums. Overwrap for the 5-gal. size is rectangular. All sizes stack at least 60 ft. high.

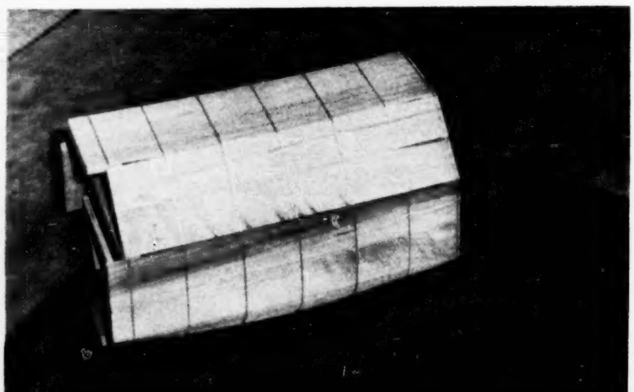
►**Low Cost, Long Life**—Since wooden overwraps are significantly less expensive than steel drums, the new composite containers can lead to big savings in initial packaging costs. For example, DB&B quotes the cost of the 55-gal. wood overwrap as 40% less than an 18-gage steel drum, over 50% less than a 16-gage steel drum.

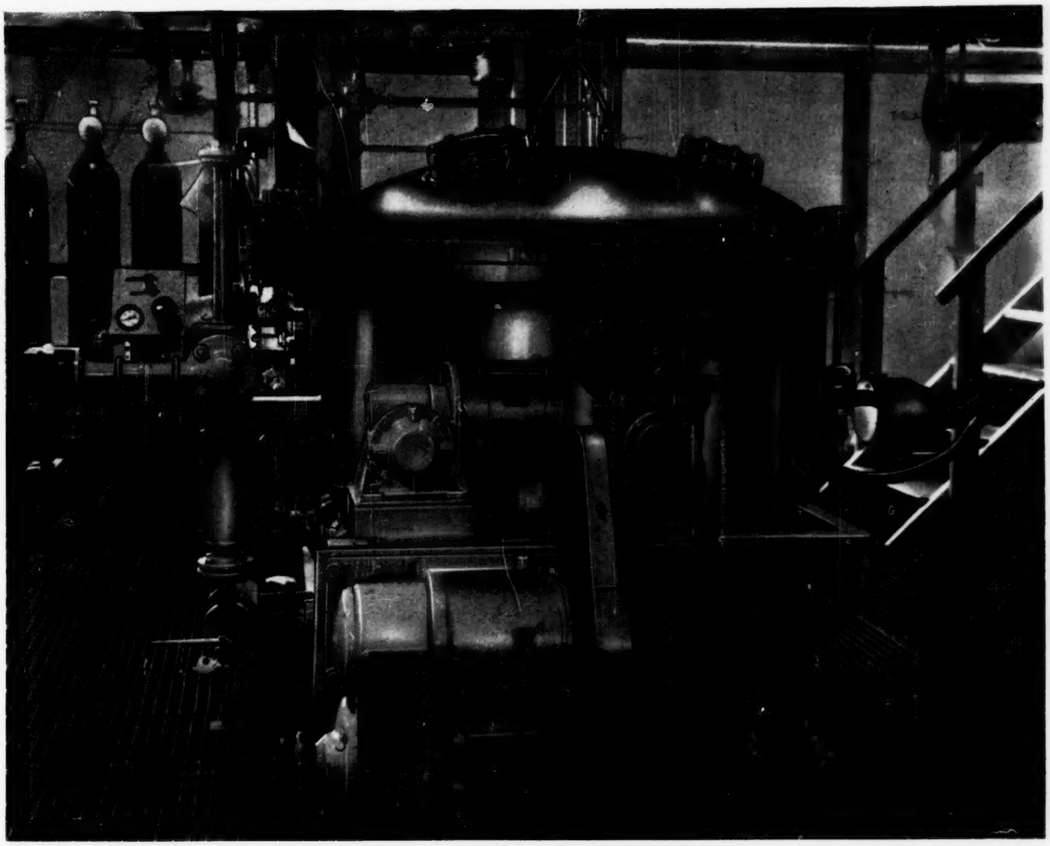
As for serviceability, DB&B expects the new shells to last 50% longer than steel.

In marketing the containers, DB&B will offer them as assembled units, or will supply the inner poly drums and suggest that overwraps be obtained from any box manufacturer prepared to furnish them.—**Delaware Barrel & Drum Co., Wilmington, Del.** **46A**

New Equipment continues on page 124.

DROPPED from a height of 4 ft. onto a steel plate, water-filled composite shows no damage. (Note wall "give" at instant of impact.)





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CUSTOM-BUILT solution

for a filtration problem

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The design of this new rotary pressure scraper filter represents another achievement for Filtration Engineers in the design of filters for special applications.

If you have a problem in solvent processing . . . or any other filtration problem . . . contact Filtration Engineers for specific recommendations which are available without obligation.

Your individual requirements determine the type of filter needed, its size, construction materials and the special features necessary for highest efficiency. For more complete data, see the FEinc section in Chemical Engineering Catalog or write Dept. CEF-1259.

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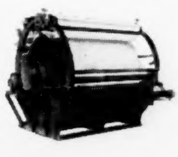

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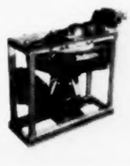
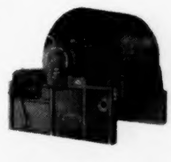


HORIZONTAL



SCRAPER

SPECIALISTS IN LIQUID-SOLIDS SEPARATION

DEVELOPMENTS . . .

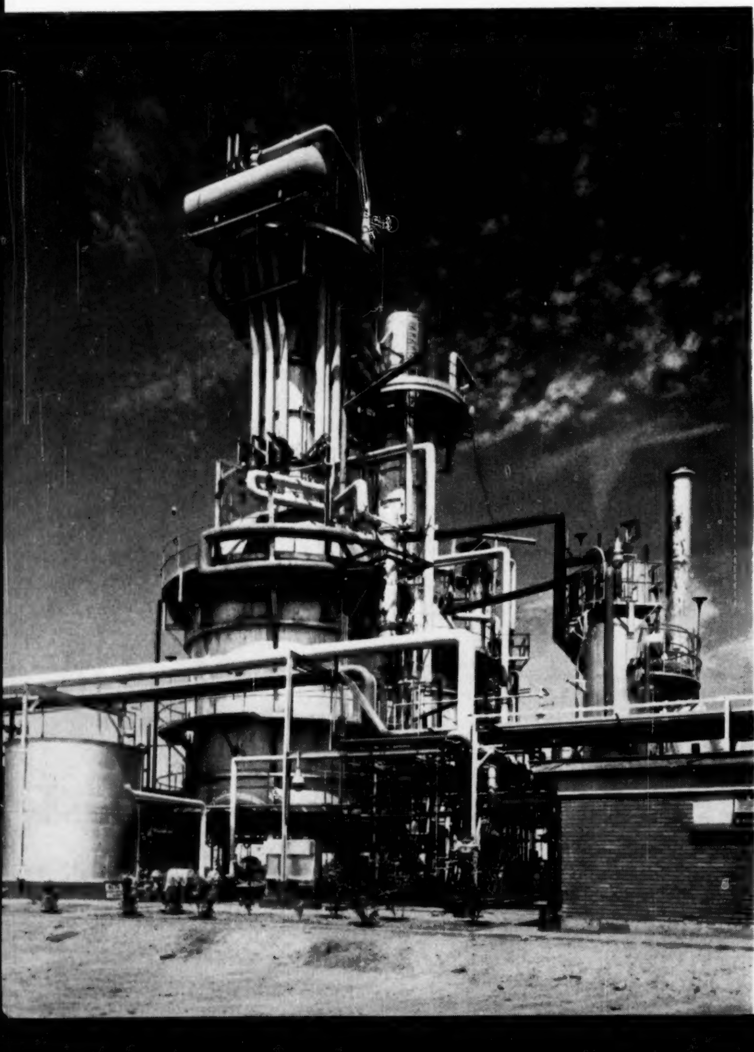
PROCESS FLOWSHEET

R. A. LABINE

Natural Gas Moves Into Steel Making

PROVED commercially successful in a 200-ton/day plant, the HyL sponge iron process now claims the distinction of being the most fully developed of the current flock of direct reduction processes. The M. W. Kellogg Co. is now building an additional 500-ton/day sponge iron plant for Hojalata y Lamina—the process developer—in Monterrey, Mexico, and Premium Iron Ores recently announced plans to erect a 150,000-ton/yr. HyL plant in Canada.

REFORMING FURNACES convert natural gas to reducing gas.

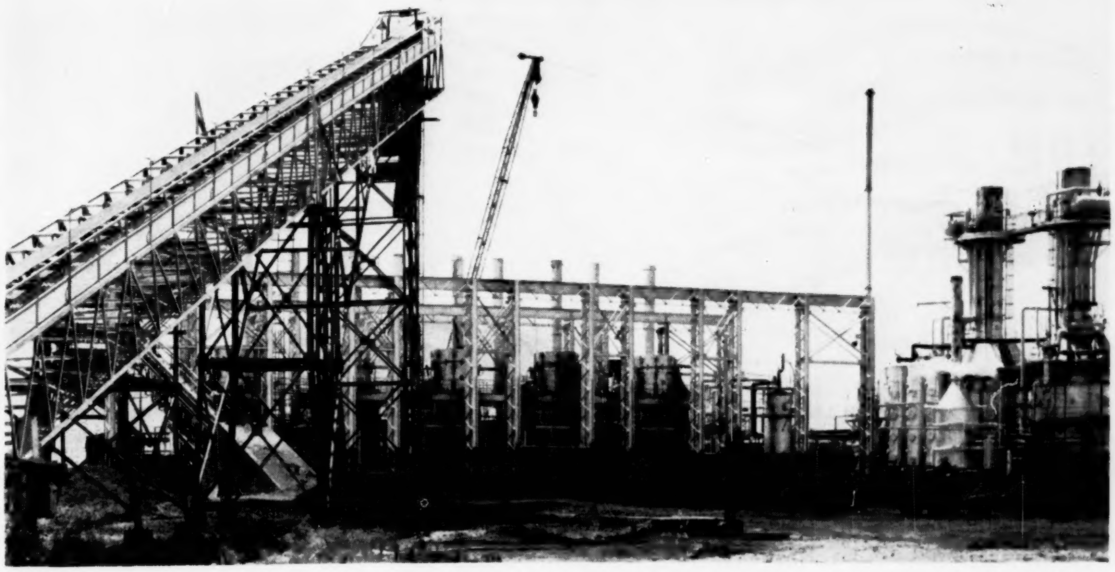


The HyL process is one of several processes now receiving wide attention as means of eliminating the blast furnace in steel production. Drawbacks of the blast furnace are high capital investment and the need for coking-grade coal—both commodities being in short supply in many areas of the world. The HyL process, on the other hand, uses natural gas instead of coke and required a capital outlay of only $45 per annual ton of capacity for the 200-ton/day plant. Through engineering improvements, cost of the new 500-ton/day plant will be pared down to $29-30 per annual ton. M. W. Kellogg is the exclusive worldwide sales and licensing agent for this process.

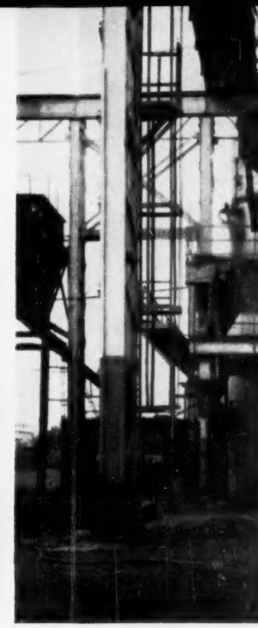
▶ **How It Works**—Briefly, the process consists of a batch reduction of lump iron ore by reformed natural gas. After reduction to iron sponge, reactor charge is dumped into a hopper for transfer to an electric furnace where sponge is mixed with scrap and refined to finished steel.

In the present 200-ton/day plant in Monterrey, incoming natural gas is first preheated in one of two reforming furnaces, then passed through a

Unfold Flowsheet



UP: Belt conveyors carry the iron ore up to the bucket of a crane which then transfers the ore to the reactors.



IN: Ore is charged to re

desulfurizing drum. Returning to the furnace tubes, gas then reacts catalytically with steam to make hydrogen and carbon monoxide. Hot furnace effluent flows to a waste-heat boiler and then to a quench tower where it contacts cool water which removes excess water vapor from the gas. Average analysis of the dry reformed gas is 73.1% H_2, 16.3% CO, 6.6% CO_2 and 4.0% CH_4.

▶ **Reducing Cycle**—There are five reactors in the plant: two are always on the primary reducing cycle, two on the secondary reducing cycle and the fifth is off stream being unloaded and recharged with fresh ore.

Reducing gas after preheating enters the primary reactors; final reduction temperatures range from 1,600-1,900 F. After this pass, gas is somewhat depleted in hydrogen and contains water vapor from the reducing reaction which must be removed in a quench tower. Gas then is reheated and passed to the secondary reactors. Depleted gas then passes through a final quench tower and is finally burned for fuel in the plant's furnaces. After reduction cycle is complete, natural gas is blown for 2-3 min. through the hot sponge to deposit carbon for optimum steel furnace operation.

During the plant's five-hour operating cycle, each reactor spends two hours on the primary cycle, two hours on the secondary cycle and one hour off stream. Eight men per shift are needed to run the plant. To make one ton of sponge requires about 21,000 cu. ft. of natural gas and 70 kva. of power; the new 500-ton/day plant reportedly may consume as little as 17,000 cu. ft. of gas per ton.

▶ **Inside the Reactors**—Each of the five reactors holds about 15 tons of ore. Reduction is only carried to 85% of completion since early tests determined that this was the optimum economical point for production of finished steel. Typically, degree of reduction varies from 96% at the top of the 5-ft. bed to 73% at the bottom.

Reactor is essentially a movable retort attached to a fixed, flanged head through a series of hydraulically operated bolts. The exit duct for gases from the bottom of the retort also employs a specially designed coupling for rapid disconnection.

Once the reducing cycle is complete, reactor vessel is uncoupled by remote control and rolled away from the head to dumping position. Vessel is then hydraulically tipped to discharge the reduced ore into a waiting hopper for transport to the electric furnace. Entire reduction process for all reactors is controlled from a central control house.

▶ **Ore Treating**—Mexican iron ores charged to the Monterrey plant are rich in iron, a typical analysis running 20% magnetite and 45% hematite.

Ore is crushed and screened to sizes ranging from ¼ to 1½ in. Up to 20% of the ore charged to reactors is minus ¼ in.; a higher percentage would impede passage of gas through the ore while a greater quantity of large lumps would not be readily reduced.

Sulfur content of the ore is reduced about 85% during the course of the

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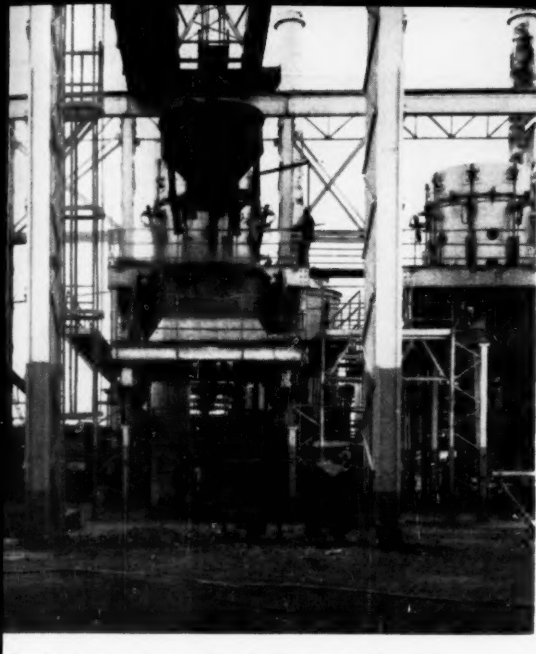
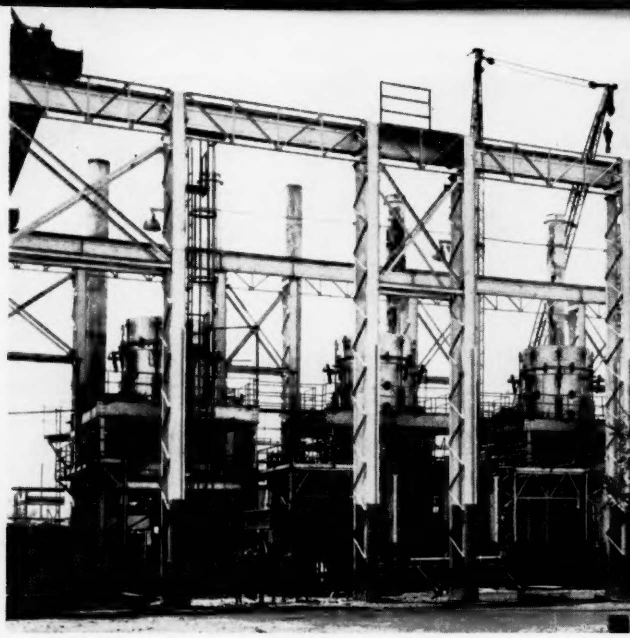


Ore is charged to reactor by an overhead hopper.



UNDER: Loaded reactor rolls under the fixed head and refor

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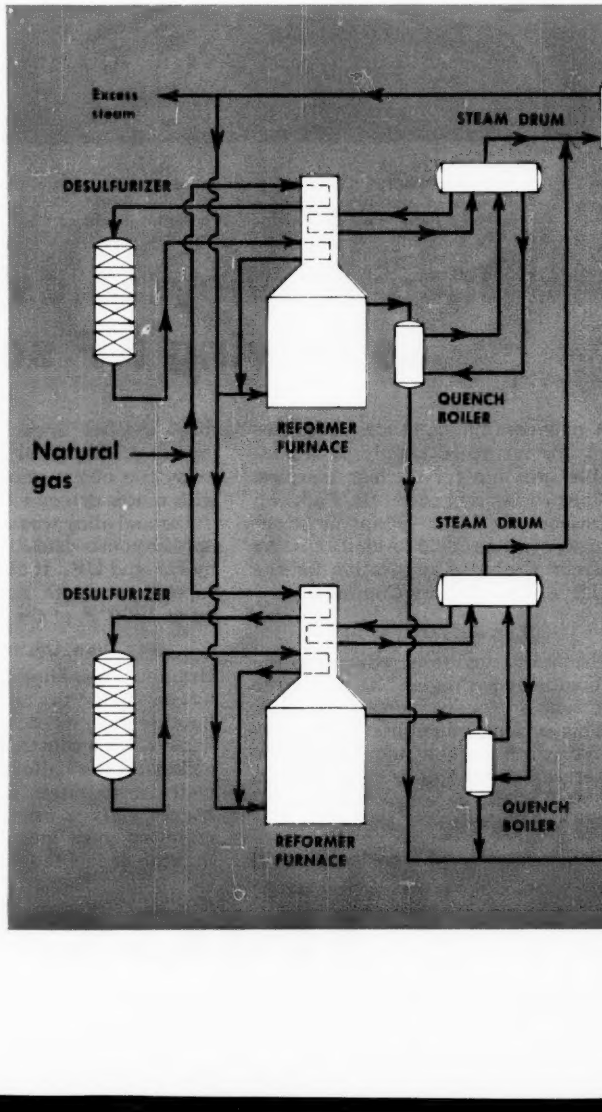
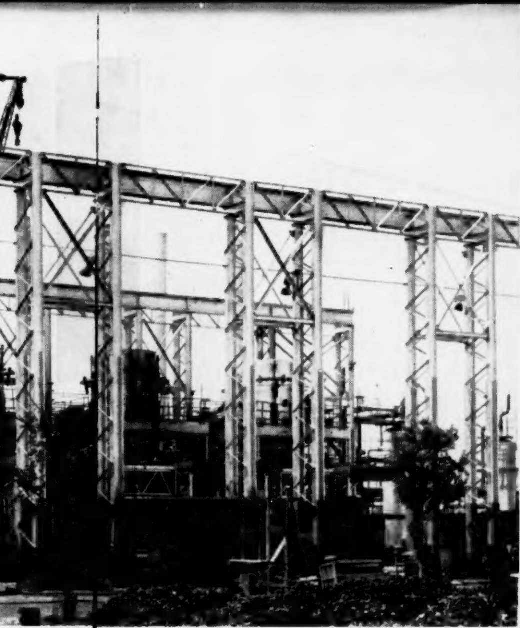
reduction reaction, final sponge containing about 0.06% S. Process does not remove phosphorus, however, so if high-phosphorus ore is used, the steelmaking furnaces must be equipped to remove this element.

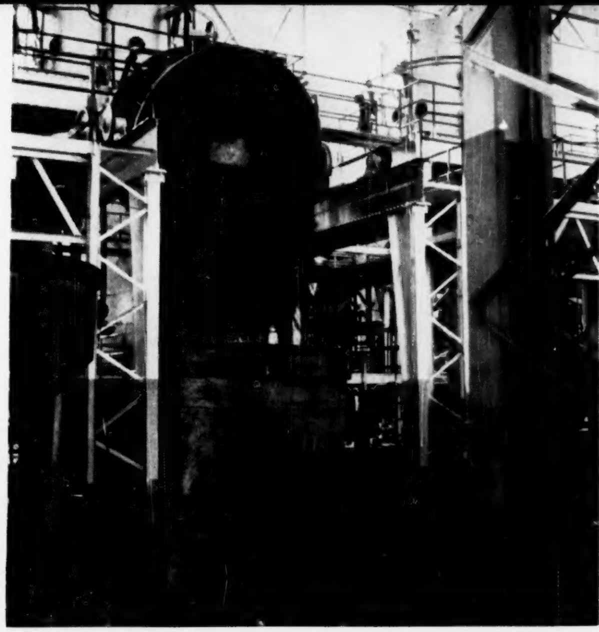
▶ **Background on the Process**—In 1953, Hojalata y Lamina started experimenting with reducing iron ore with natural gas in a tunnel kiln in a 12,000-ton/yr. unit. This method created more problems than it solved, so the firm built another experimental installation around a Madaras retort—and this method, too, proved unsatisfactory because of problems in the pulsating valve and reducing gas produced.

Finally deciding to strike out on their own, engineers at Hojalata y Lamina developed the prototype of the HyL process. Kellogg, originally called in to design the gas reforming system for the pilot plant soon was involved in design of the 200-ton/day plant. This unit went into operation in March 1958 and recently produced its 100,000th ton of sponge iron.

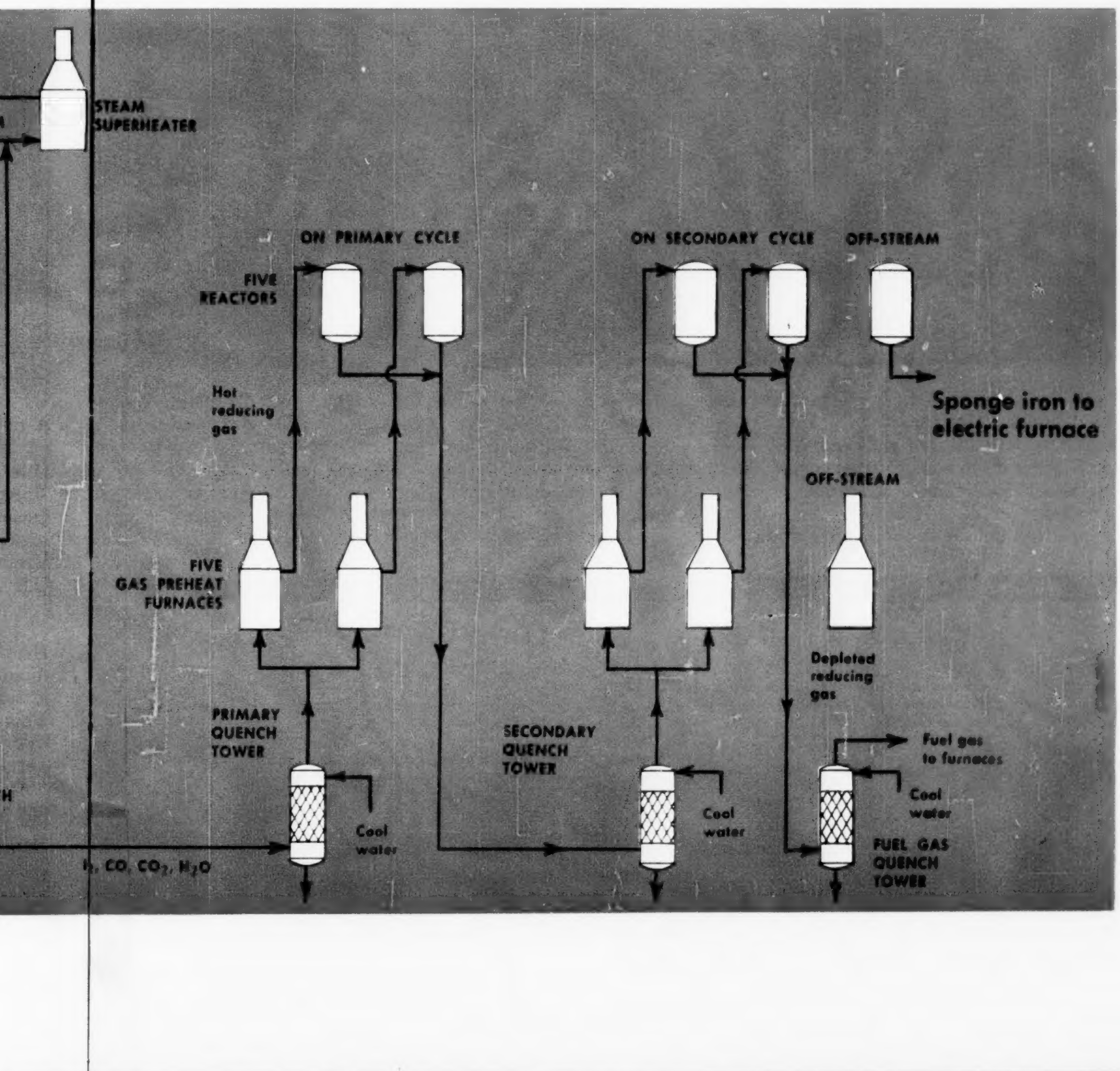




reformed gas is blown through to reduce the iron ore.



OUT: After reduction, reactor rolls out and dumps the iron.



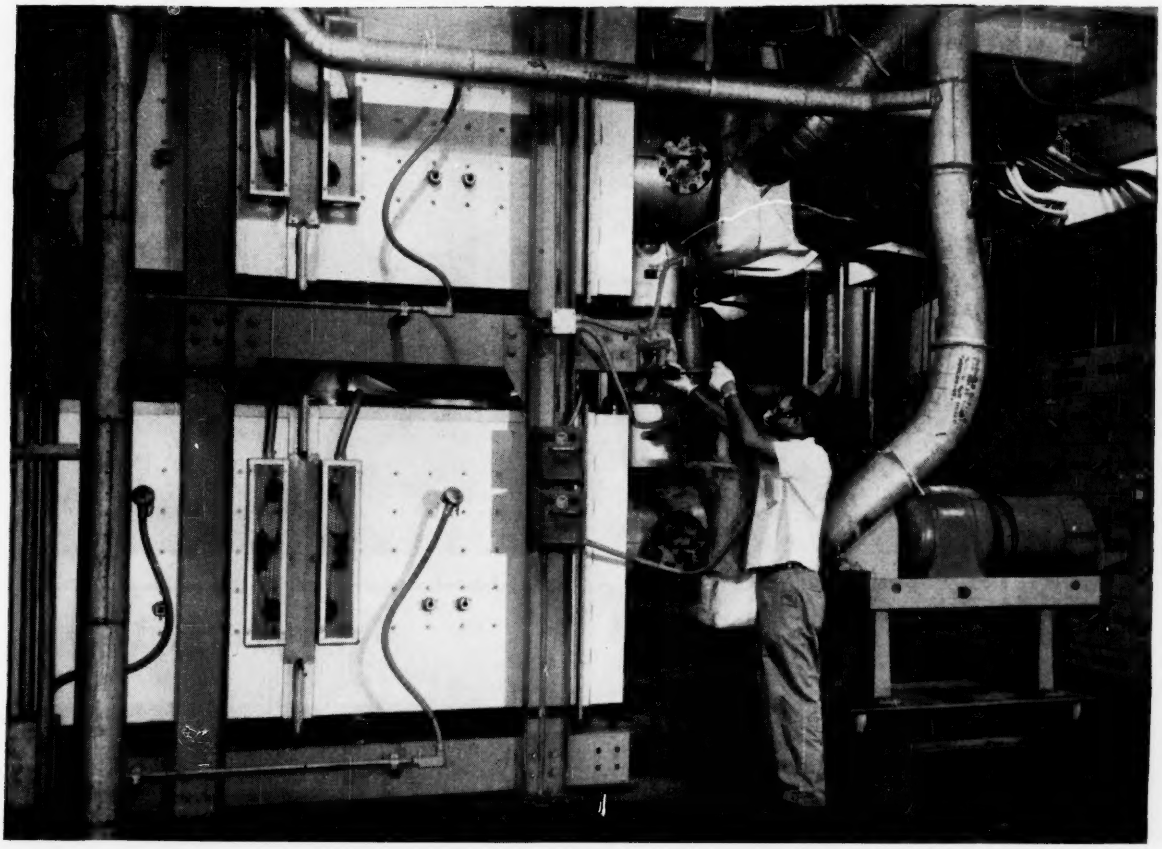


Photo courtesy Paducah Gaseous Diffusion Plant

NEW UF_6 PROCESS has made possible continuous production of uranium hexafluoride. In the operation pictured here, uranium dioxide is hydrofluorinated to uranium tetrafluoride in a special reactor with three Inconel alloy tubes. Inconel alloy is used because of its resistance to HF, even at high temperatures.

Inconel alloy holds down corrosion as flowing HF soars to 1000°F

A new continuous process provides an uninterrupted supply of fissionable uranium for nuclear reactors. The process is in use at the Paducah Gaseous Diffusion Plant in Kentucky, which is operated by the Union Carbide Corporation for the U.S. Atomic Energy Commission.

Converts UO_3 to UF_4

Uranium trioxide is reduced to the dioxide by hydrogen. UO_2 is fed into a reactor for conversion to UF_4. This is done by counterflowing anhydrous hydrogen fluoride at temperatures varying from an initial 500°F at entrance to a final 1000°F at the UF_4 exit.

The reactor used here consists of three Inconel* nickel-chromium alloy tubes. They are arranged horizontally, one above another, equipped with motor-driven ribbon screws.

Inconel alloy was selected for this application because it resists attack by HF and UF_4. It also provides the superior strength needed to stand up at 1000°F, at the UF_4 exit.

Then, UF_4 to UF_6

Uranium hexafluoride is produced by reaction of the tetrafluoride with fluorine in a vertical water-cooled flame reactor constructed of Monel* nickel-copper alloy. The reactor wall temperature is 1000°F and Monel alloy is used because of its stubborn resistance to attack by fluorine at this temperature.

Both Inconel alloy and Monel alloy have the additional advantages of being easy to fabricate and weld. And both are readily available, usually from warehouse stocks.

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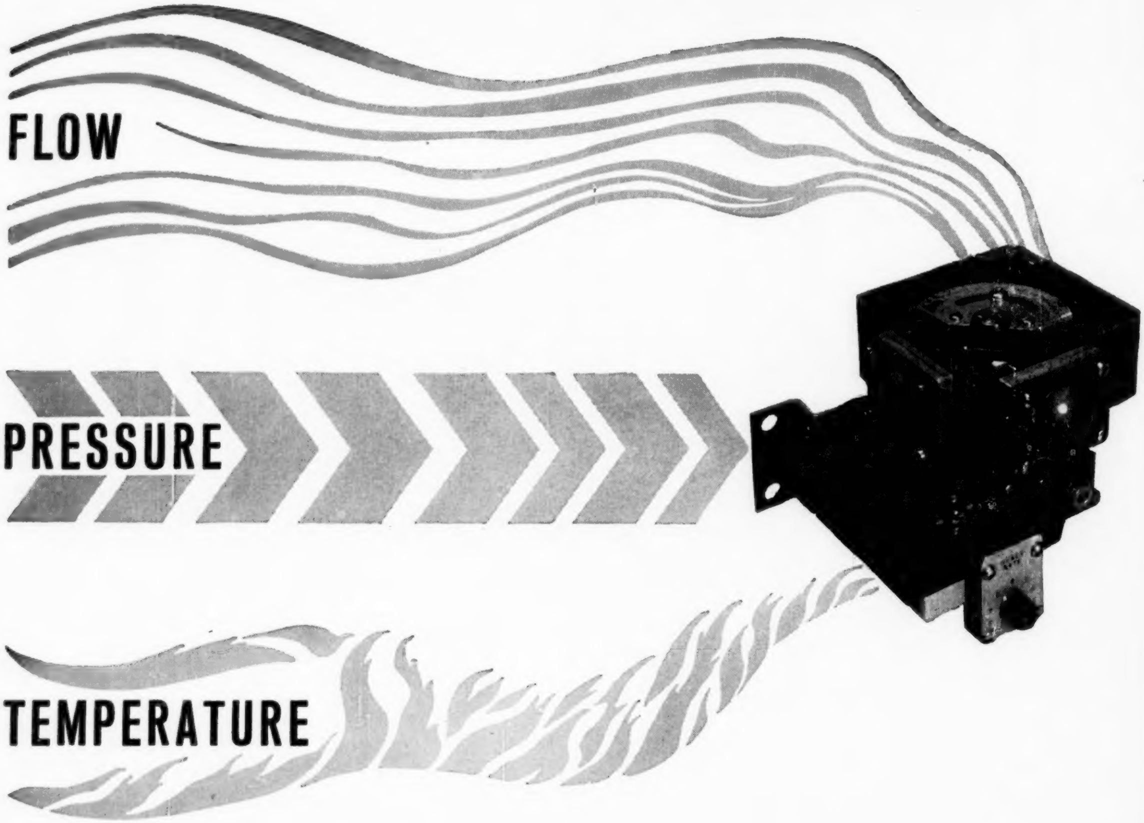

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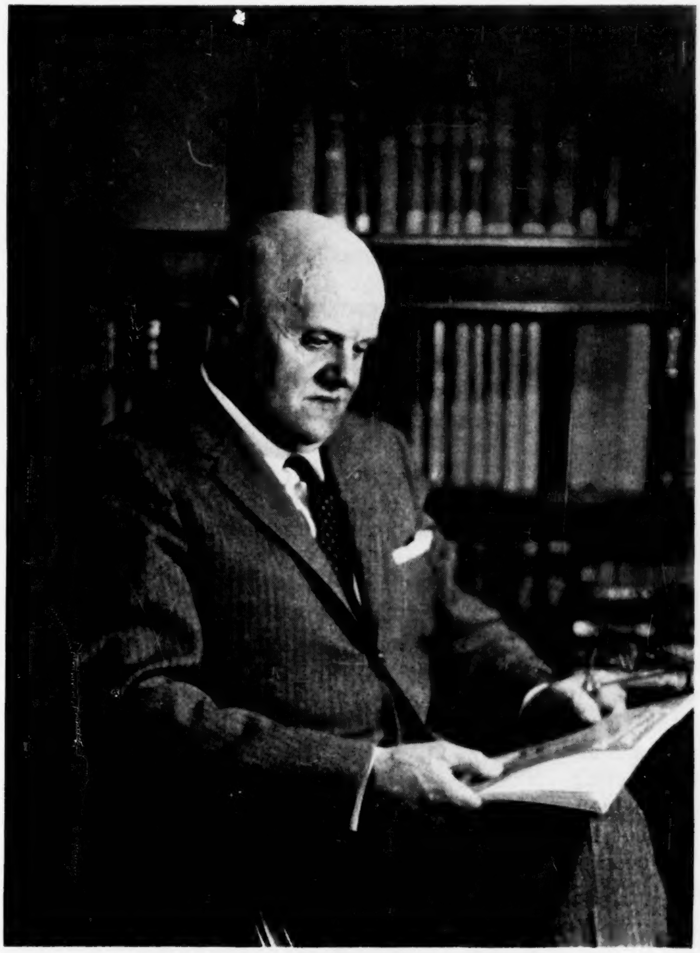
Chemical Engineering
December 28, 1959



On His Retirement From McGraw-Hill . . .

Engineers Salute Kirkpatrick

PAUL D. V. MANNING, Pasadena, Calif.

EVERY great profession has been built on a foundation of ideas propounded by thoughtful men. Such ideas are planted as seeds of a vital need and fertilized by a foreknowledge of what the future can hold. Once the idea has sprouted, it is generally nurtured under the leadership of some one person with magnetism, drive and tenacity sufficient to sustain faith and interest.

This, I think, has been the history of chemical engineering.

The idea men—actually the apostles of the profession—included Arthur D. Little and William H. Walker, Leo H. Baekeland and Harry A. Curtis, John V. N. Dorr and D. D. Jackson, Warren K. Lewis and James F. Norris, Howard C. Parmelee and Charles Reese, E. R. Weidlein, M. C. Whitaker and Alfred H. White.

But the man of leadership, magnetism and drive who nurtured the original idea—who pushed and prodded the new profession until it was able to stand on its own feet as a strong and distinctive engineering discipline—that was Sidney Dale Kirkpatrick.

We of the chemical engineering profession appreciate our good fortune that, at the opportune time, a man of Sid's capabilities was available for the job—a man of warm friendliness and broad vision, liking people and tolerant of their foibles, possessed of a creative imagination which he used always for the benefit of others, never for himself. That the publishers of *Chemical Engineering* recognized Sid's qualities and supported his ideas is a credit to them as well as to him.

Probably no other profession has developed so rapidly, nor come to such a state of vigor so early in its history. At the same time, seldom has a professional journal become so strongly identified with, and personified in, its chief editor. Over the years Sid and *Chemical Engineering* have come near to being one and the same in the minds of much of the chemical engineering audience.

Sid's influence has been felt not only in technical publishing, but in every facet of the chemical industry as well. He has been a behind-the-scenes advisor to heads of the industry and an anonymous confidant of corporation presidents. In no small way, many owe both their positions and their success to his wise and objective counsel.

We of the chemical engineering profession are happy that Sid's retirement from McGraw-Hill will not mean the end of his influence in the industry and profession. Rather, it will furnish still more opportunities for him to do what he has always done—to add his voice and his pen to the job of building an ever greater field and appreciation for chemical engineering. We of the profession, in industry and in education, salute you, Sid, as friend, counselor, engineer, editor—as Mr. Chemical Engineering.

Paul DeVries Manning, now professor of chemical engineering at California Institute of Technology, Pasadena, retired last year as senior technical vice president of International Minerals & Chemical Co., Chicago. Before his Intminco connection he was for many years a consulting engineer and our local editor in San Francisco.

S. D. Kirkpatrick, Engineer-Editor

From childhood, Sidney Dale Kirkpatrick's hobby has been people. Now that he is retiring from the position of editorial director of McGraw-Hill's two "chemical papers," he will be able to pursue that hobby still more intensively. At the same time, he will be concerned with continuing activities of McGraw-Hill Book Co. as a vice president and consulting editor; and as director of several chemical firms.

Sid earned his BS in chemical engineering from University of Illinois in 1916. After a period of graduate work and a stint with the Illinois State Water Survey, he joined the U. S. Tariff Commission, soon resigning to go to Europe with the AEF as a lieutenant in the Sanitary Corps and Engineers. After the war he remained to assist the American Commission to Negotiate Peace, before rejoining the Tariff Commission. Two years later the publishing field called him, and he became an assistant editor of *Chemical & Metallurgical Engineering.*

In 1928, when the late Howard C. Parmelee was elevated to become McGraw-Hill's vice president and editorial director, Sid took his place and continued as chief editor until 1950 when he assumed the mantle of editorial director of *CE* and *CW*.

Sid's honors and activities have been numerous. Dr. Manning, in the adjoining column, relates how the profession sees him, but without detailing how he got there.

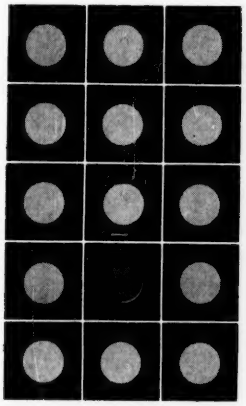
In 1929 he became consulting editor of McGraw-Hill's Chemical Engineering Series, now numbering over 30 titles. In 1932 he planned and edited the AIChE Silver Anniversary Volume. He became AIChE president in 1942 and, in 1944, president of the Electrochemical Society. His awards include honorary doctorates from Clarkson and Brooklyn Poly, the Chemical Industry Medal (SCI), AIChE Silver Anniversary Medal, CMRA Memorial Award and AIChE Founders Award.

Several months before the end of World War II Sid went to Europe as an "assimilated" brigadier general in the Technical Industrial Intelligence Commission, charged with ferreting out Germany's industrial secrets almost before the smoke of battle had cleared. In 1946 he was chosen as consultant to the Secretary of War for Project Crossroads—the Bikini atom bomb tests. During 1950-55 he was chairman of AEC's advisory committee on information for industry.

Almost continuously, it would seem, Sid had been a consultant. At various times he has served the War Manpower Commission, War Production Board, Army Chemical Corps, U. S. Quartermaster Corps and the Secretary of War.

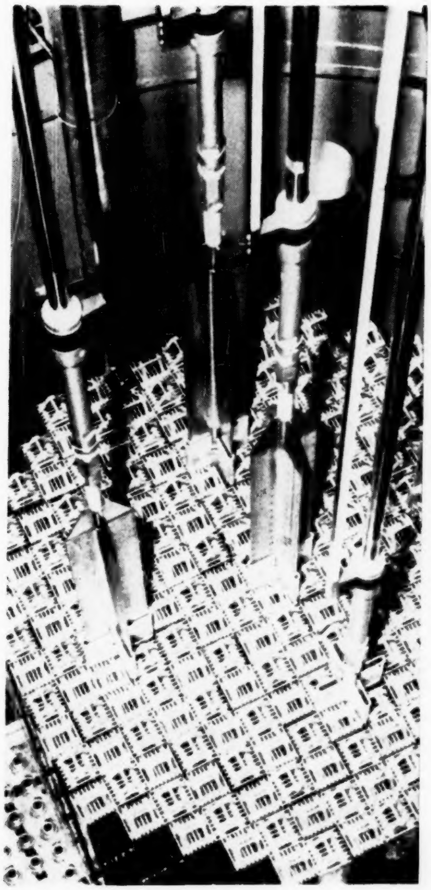
Two of his proudest days, Sid says, came 25 years apart. The first, in April 1934, was when Hitler banned *Chem. & Met.* permanently from Germany for a highly critical editorial. The second, this fall, was when *Chemical Engineering* and *Chemical Week* designated their Achievement Awards the Kirkpatrick Awards.—TRO

New challenge for chemical engineers . . .



Nuclear Power Fuel Reprocessing

***Chemical Engineering* presents a new series to bring you up to date in this expanding, important area of chemical processing.**



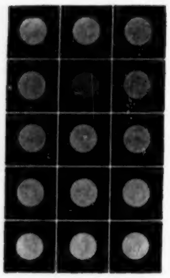
WITH this issue *Chemical Engineering* begins a series on nuclear power fuel reprocessing which will run through the next four issues.

We feel that this is an important series because nuclear fuel reprocessing is chemical processing and therefore in the domain of the chemical engineer. Your company may be among those eventually operating private reprocessing plants. You should be prepared for that eventuality.

These articles are based on papers presented at an AEC symposium on nuclear fuel processing which was held at Richland, Wash., last September. This was not the first symposium on fuel reprocessing. It was, however, the first in which the papers presented dealt with what will be done rather than with what people would like to do. It was a solid-down-to-earth meeting where engineers from the AEC's four processing sites (Hanford, Idaho, Oak Ridge and Savannah River) gave papers full of solid engineering facts.

The primary mission of the AEC is weapons. It does not want the job of running private power reactors or the job of reprocessing spent fuel from these reactors. However, there is no private enterprise now engaged in fuel reprocessing and none is contemplated. Thus the AEC has the job by default. And hence the purpose of this symposium, to aquaint private industry with the technology and approximate costs of fuel reprocessing in hopes that some company or companies will eventually take over the job.

The first two articles, appearing in this issue, introduce the series just as the original papers were introductory to the symposium. They provide background information on the fuel reprocessing program that should help you better understand the later, more technical articles.



In Nuclear Fuel Reprocessing the AEC has Two Objectives

Service to private reactor operators and

GEORGE F. QUINN, Director, Division of Production, Atomic Energy Commission

Basically, the role of the AEC in power fuel reprocessing is twofold:

• Because of the absence of a commercial chemical reprocessing service, the AEC has agreed to accept irradiated fuels in unprocessed form. The AEC will make financial settlements with reactor operators providing for chemical treatment of the irradiated elements in which the special nuclear material will be converted to the standard form on which credits and fair prices are based. These forms are UF_6 for $U^{235-238}$ mixtures, metal buttons for plutonium and uranyl nitrate for U^{233}.

• To help establish chemical reprocessing as a commercial enterprise, the AEC has conducted a continuing program of research and development on reprocessing methods and has arranged for wide dissemination of technical information as it becomes available.

This series is directed primarily toward the informational phase of the AEC program. It is, however, related to the services phase in that discussions will include information on the methods to be used when fuels from civilian reactors are returned to the AEC.

The Federal Register Notice of March 12, 1957 specified that charges for AEC services would be based on the estimated cost of chemical processing in an assumed multipurpose plant, referred to as the conceptual plant. The technology chosen for this plant, while not proved out in the laboratory, was specified primarily for identifying those services to be included in the charges.

The AEC had no plans for actually handling the irradiated elements returned from civilian reactors—we were still optimistic that a privately owned processing plant would be built. Later, when there appeared to be no early prospect for such a commercial enterprise, the AEC began planning actual handling and treatment of these materials. These plans are still being developed. The virtue of the conceptual plant, therefore, was that it permitted us to define to the reactor operator those services and related charges which would be an integral part of his over-all economies, even though the processing technology was undeveloped.

How the AEC plans to handle these fuels will be discussed in more detail later in this series. However, the information presented will not affect the AEC processing charges since these are based on the conceptual plant. The capabilities to be installed in the AEC facilities will be, at the minimum, equal to those services included in the conceptual plant.

It is the AEC's intention to process returned fuels in existing facilities after some modifications. This intention is based on two objectives: first, recovery of the valuable source and special nuclear materials which will be present in irradiated fuels and, second, development, on a specific basis, of handling and processing techniques for power reactor fuels. We hope the latter will yield information valuable to the establishment of a commercial processing facility.

The various articles in this series will discuss modifications to existing AEC facilities for the receipt and processing of irradiated fuels from a number of foreign and domestic licensed reactors. Since existing AEC plants are based on the aqueous method of recovering uranium, thorium and plutonium from irradiated fuels, we will deal with aqueous processing technology.

Much information was made available on aqueous processing methods at several sympomiums held in the U. S. and abroad. This series, therefore, is a continuation of our informational program directed toward providing the latest available technical advances in fuels reprocessing. We hope this information will provide a more substantial basis for further studies and evaluations by potential commercial processors. As a further assistance in analyzing the components of a self-contained processing facility, the AEC plans to complete by July 1960, a preliminary plant design incorporating the latest aqueous processing technology.

I think it would be appropriate to review the general reasons for the AEC's selection of a plan for actual processing of returned fuels in existing facilities at Hanford, Idaho, Oak Ridge and Savannah River rather than constructing a new multi-purpose reprocessing plant. The possibility that some or all irradiated fuels might be accepted by a private processing facility by the middle or late sixties was a major factor in selecting the alternatives with the lowest capital investment. Other factors which led to this decision were:

1. The AEC has already established at some of its sites special processing programs which are closely related to the processing of new power fuels.
2. Solvent extraction capacity within the AEC complex appeared adequate to handle the amounts of fuel expected over the next several years.
3. The large variety of fuel types required much development effort. Each site was able to concentrate on a limited number of fuel types.
4. A change in processing loads would not seriously affect the level of operations at any one of the sites since each site considers this source of fuel feed as an increment to its basic program.
5. Maximum use of existing facilities (solvent extraction, services etc.) allows us to delay the start of modification until the latest pos-

Information for potential private reprocessors

sible moment. This gives us additional time for developing new receiving and dissolving techniques.

6. As we gain experience in the handling of fuel elements, many changes in the processes selected may be indicated. A low initial capital investment should make later improvement of the processes attractive.

I hope the above listing of our reasons for selection of the four existing facilities for the interim period until private industry can assume this work will help you understand our approach to the assignment of fuel processing responsibilities.

The processing schemes selected at each site may not be the best for a privately owned plant. We do not know yet what type or size of plant or chemical treatment should be considered as the first choice for private enterprise. With experience in the receipt and dissolution of advanced fuels, we should eliminate a great number of the unknowns in this field. The close relationship which must exist between the reactor operator and the AEC chemical processor will undoubtedly lead to an exchange of information that will help to reduce the cost of the fuel cycle.

In discussing aqueous processing, we initially think of solvent extraction. This series, however, will stress the receiving and dissolving steps of the processing cycle. There are two reasons for this area of emphasis. First, development work has been restricted to installed solvent extraction equipment, supporting services and utilities and, second, these solvent extraction processes for the recovery of uranium and plutonium from irradiated fuels were adequately treated in previous meetings and reports. Further, development work has indicated that we can use dissolution methods for the advance fuels yielding dissolver solutions which can be handled by known extraction technology. We used these development leads as the bases for investigation of the dissolution processes best suited for coupling with the existing extraction processes.

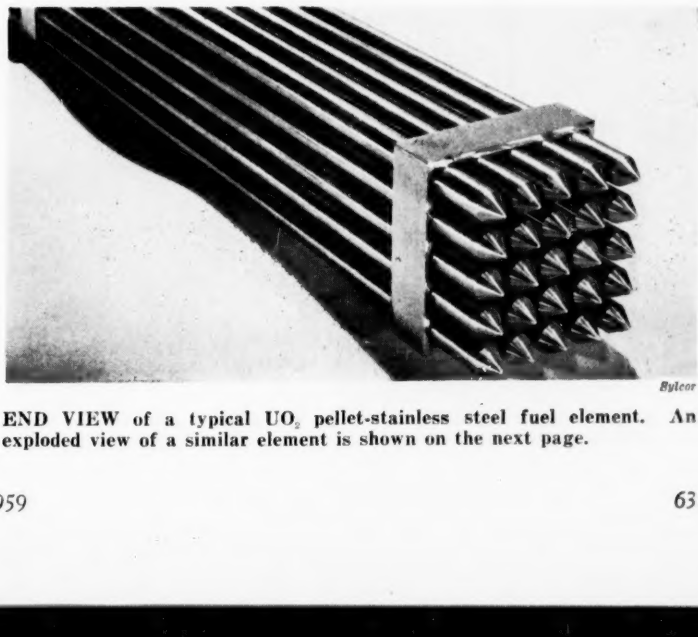
We will not include in this series discussion of non-aqueous processing schemes. The development contributions of the non-aqueous program, coupled with the experience accumulated in the aqueous processing program, should provide both the AEC and industry with a firm basis upon which to judge the concepts and assumptions that should be used for design of any new chemical processing plant. Development work on the aqueous dissolution processes has already reduced somewhat the concern of the chemical processor toward changes in fuel element composition and cladding material.

I wish to emphasize that the information and experience accumulated by the AEC during the interim processing program will be available to industry. We encourage discussions between the AEC processor, the reactor operator and the fuel fabricator on the effect of fuel composition changes on AEC processing equipment. Our experience in the AEC production system has emphasized the value of close collaboration between these parties.

Civilian power fuel cycles involve at least three different operating organizations for various phases of the fuel cycle. This arrangement causes communication difficulties. I feel that extra effort in exchanging different points of view can overcome these problems.

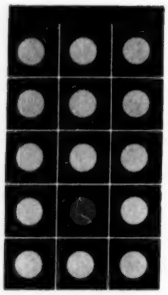
Discussions have already taken place between some reactor operators and the AEC concerning a study on the scope of a small reprocessing facility at, or near, a power reactor site. Initial phases of this study should identify to both parties the requirements for the different types of facilities.

We hope the AEC plans for reprocessing the various fuels will stimulate discussion and effort leading to a reduction in the cost of the fuel cycle.



Sylcor

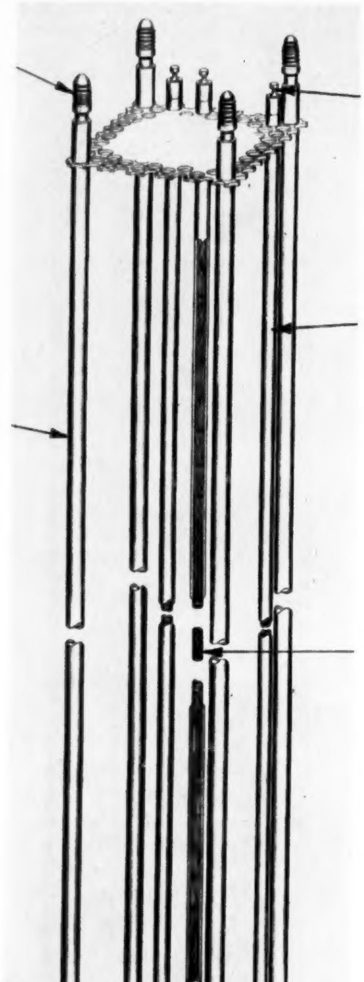
END VIEW of a typical UO_2 pellet-stainless steel fuel element. An exploded view of a similar element is shown on the next page.



Program Has Wide Scope

New plants, new fuels, new processing techniques, new materials of construction

FRANK P. BARANOWSKI, Chief, Chemical Processing Branch, AEC Div. of Production



In this series, we will restrict chemical processing to the unit operations from receipt of unruptured irradiated fuels through the preparation of decontaminated nitrate solutions of uranium, thorium and plutonium. Conversion of uranyl nitrate (other than U^{233}) to UF_6 and plutonium to plutonium buttons will not be covered. We will also restrict the presentations to the processing methods of each site on its assigned fuels. The fuels included are those to be shipped from reactors in operation, under construction and, in one case, in a very advanced stage of planning.

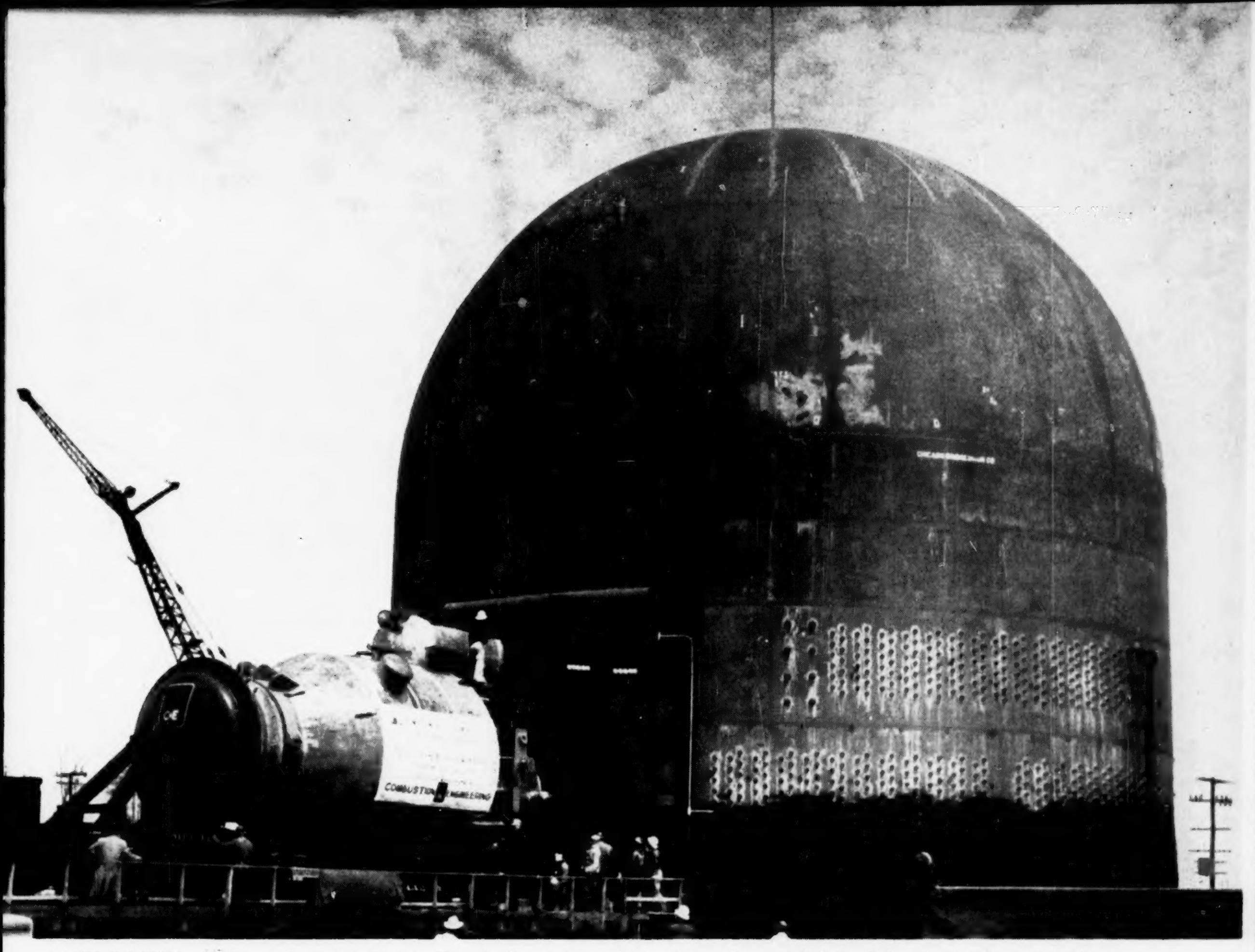
We will not attempt to present an exhaustive treatment of the various combinations of processing methods and fuel types. Rather, we will try to acquaint you with how the AEC is set up, or will be set up, to handle the various fuels from reactor operators.

The general distribution of the fuel types assigned is as follows:

1. Current planning has all highly enriched fuels processed at the Idaho plant. No plutonium handling facilities are now available at this site.

2. Hanford will process the major portion of the low enriched fuel load (less than 5% U^{235} enrichment) in an arrangement that will not interfere with the basic production program at that site.

3. Oak Ridge has responsibility for processing thorium type fuels and the foreign 20% enriched uranium-aluminum alloy fuels. Oak Ridge will install equipment which will parallel, to some degree, equipment to be installed at Hanford for stainless steel clad fuels. To use this equipment, as well as for other reasons, such as providing fission product feed to the Fission Product



NEW POWER plants, such as the Enrico Fermi plant shown here, demand expanded facilities for fuel reprocessing.

Pilot Plant at Oak Ridge, we have assigned some stainless steel clad low enrichment fuels to Oak Ridge.

4. Savannah River will handle the large intermediate enriched load from the PRDC (Enrico Fermi breeder reactor at Lagoona Beach, Mich.) and the long elements of natural enrichment from the Canadian reactors. Savannah River has changed the geometry of its large dissolver to a critically safe one by the addition of inserts. They have also installed instrumentation to indicate slight changes in uranium concentrations so that they can maintain U^{235} concentration in dilute solutions at a safe level.

As mentioned by Mr. Quinn, we will confine the discussions to the receiving and dissolution steps of the processing cycle.

Regarding the receiving step, we have had very little information on the cask [A cask is a shipping container for irradiated fuels—Ed.] shipping procedures proposed by the shippers of irradiated fuels. Therefore, we had to establish cask acceptance criteria for each site with our previous experience in handling irradiated fuel, the installed handling facilities at the sites and our interpretation of the probable methods of handling and shipping highly irradiated fuels as guides.

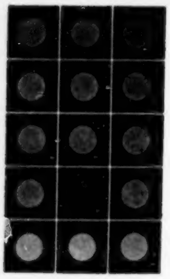
Sylcor

NEEDLES of uranium, for Enrico Fermi reactor, are only one of many forms of nuclear power fuels.

Fuel types assigned to each site govern the dissolution system. In some cases, the dissolution systems are those that now appear most promising. We may make adjustments if new data indicate a substantial advantage and if we have not made major commitments on equipment and other capital expenditures.

Let us discuss briefly the processing methods at each of the sites.

▶ **Idaho**—The Idaho processing systems were installed primarily for process development work. We are using these facilities for processing during the interim period. Work at Idaho includes sulphuric acid treatment of stainless steel cermet fuels, hydrofluoric acid treatment of zirconium-uranium alloy fuels and nitric acid treatment of uranium-aluminum type fuels in



a direct maintained plant of relatively low capacity. Idaho can do nitric acid dissolution of uranium-aluminum fuels in either a continuous or batch dissolver system.

▶ **Hanford**—Hanford plans to use Hastelloy-F equipment for sulphuric acid decladding of stainless steel clad fuel, for ammonium fluoride decladding of zirconium clad fuel and for nitric acid treatment of aluminum clad fuels. This material of construction may be the answer for the long sought dissolver for these three types of fuel cladding. Also included in the Hanford modification program would be a chopper (a device for cutting up fuel

G. F. Quinn

F. P. Baranowski

George F. Quinn is a chemical engineer, a graduate of MIT, '41. His first job was as engineer and research assistant with the Office of Scientific Research and Development and the Manhattan Engineer District. In 1946, he returned to school as a chemical engineer instructor and student, receiving his Master's degree in chemical engineering from Columbia University in 1948. Mr. Quinn then joined the Atomic Energy Commission as an industrial engineer. In September, 1959, he was appointed Director, Division of Production.

Frank P. Baranowski has a BS in chemical engineering from New York University and an MS from the University of Tennessee. He served with the Corps of Engineers, then went to the Manhattan Engineer District, later to the Oak Ridge National Laboratory. In 1951 he joined the AEC Division of Production as Process Engineer; was appointed Chief, Chemical Processing Branch, Division of Production in 1957.

elements) which could be used on some of the fuels.

▶ **Oak Ridge**—Oak Ridge facilities, as those at Idaho, were built primarily for process development work. We are using these facilities to process fuels on a routine basis during the interim period. The Oak Ridge process can dissolve stainless steel cladding with sulphuric acid and zirconium cladding with ammonium fluoride in nickel equipment. Under the Oak Ridge development program, an alternate system for dissolving stainless steel will be installed. This is the Darex facility which has a nitric–hydrochloric combination (aqua regia) as the dissolving agent. The plant will also include mechanical decladding equipment for some of the fuels.

Oak Ridge is a direct maintained, low capacity plant. Therefore, in contrast to simple modification of existing facilities, as at the other sites, Oak Ridge will also build a separate head-end treatment unit consisting of two processing cells, an unloading basin and a storage canal.

▶ **Savannah River**—Savannah River now plans a combination of hydrofluoric acid and nitric acid for dissolving PRDC zirconium clad pins and nitric acid alone for the Canadian fuels. Dissolution will be done in existing dissolvers made of Type 309 Cb stabilized stainless steel.

The PRDC core contains stainless steel "bird cages" that hold the zirconium pins in a fixed geometry. Therefore, Savannah River plans to use a removable basket for accumulating undissolved stainless steel pieces.

It is apparent from the above that the AEC production and development program dictated, to some degree, the assignment of irradiated fuel. We made every attempt to assign fuels so as to reduce new capital investment. No firm cost estimates for plant modifications will be presented in this series. Engineering work is still proceeding and significant modifications to existing plants are not expected before the first of the year.

At this point I would like to identify some important contributions made by technical personnel at each of the sites. These are not all of the advances made in the last two years, but they are among the more significant. These contributions are:

- Preparation of the cask acceptance criteria for the AEC. Those with experience in this area recognize the many difficulties present in arriving at these criteria.
- Selection of extremely promising materials for dissolvers which can contain more than one of the new dissolution agents and can dissolve either aluminum, zirconium or stainless steel clad fuels.
- The technique of using inserts that make dissolvers geometrically safe from a criticality viewpoint.
- Removal of undissolved material from dissolvers with baskets.
- Development of techniques and dissolver design to permit examination of the dissolver contents after dissolution, if required.
- Development of a method to de-jacket some fuel types and also a method for chopping elements so that core material is exposed to leaching by the conventional dissolution methods.
- Actual processing of uranium-zirconium alloys and UO_2 stainless steel cermet fuels.

An important function of the processing program is the measurement of the source and special nuclear material recoverable from irradiated fuel. The dollar value of these materials is high. The power fuel processing program introduces new measurement problems at the dissolution stage of the process and the need for a good measurement plays an important part in the selection of a processing scheme for a chemical processor. For these reasons, each site will comment on the chemical plant measurement system for source and special nuclear material contained in irradiated fuels.

We feel that we have already made significant progress in the development of reasonable head-end processing schemes for a number of advanced fuel types. Experience obtained with the varied chemical and mechanical technologies at the four sites should remove many of the unknowns that currently concern a chemical processor. It is our feeling that chemical process development can keep abreast of changes in advanced fuel types which may be more difficult to process than those referred to here. However, we can greatly simplify this work, and the related capital changes, if we can realize the close working arrangement between the fuel fabricator, reactor operator and AEC chemical processor mentioned by Mr. Quinn.

C E Refresher

Heat Transfer to Moving Fluids

Conduction and convection describe mechanics of heat transfer to moving fluids; but empirical correlations are necessary to express over-all heat transfer coefficients.

JESSE COATES and BERNARD S. PRESSBURG
Louisiana State University, Baton Rouge, La.*

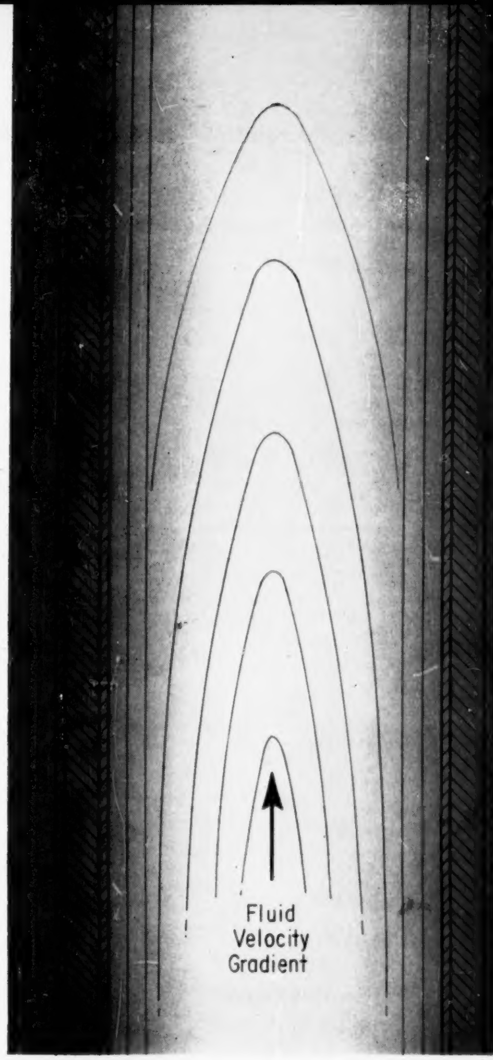
QUALITATIVELY, transfer by convection is easily described. Let's assume that the metal surface at temperature T_1 is hotter than the fluid flowing past it at an average temperature T_2 as shown in the drawing. Due to the velocity distribution,[1] the fluid immediately adjacent to the surface is moving so slowly that it is in laminar flow with no radial motion. At points further away from the surface, the flow becomes turbulent and individual molecules or groups of molecules move toward the violently turbulent core.

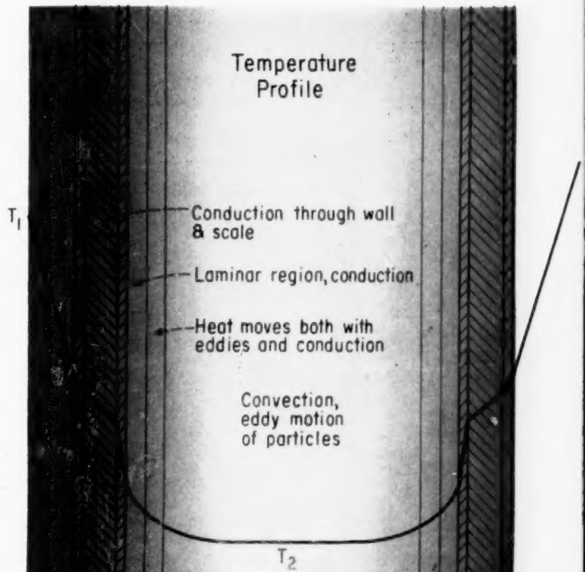
Insofar as the transfer of heat is concerned, the molecules in the laminar layer contact only the molecules adjacent to it. Heat flow through this layer, popularly called a film, is by conduction. In the turbulent regions, the molecules have more collisions and thus transfer heat faster.

Effectively, this action means that the flow of heat through the laminar layer encounters more resistance and requires a greater temperature driving force than it does while moving through the turbulent regions.

Hence, a large fraction of the difference in temperature between the wall and the bulk of the fluid occurs in the very thin layer adjacent to the wall. The intermediate or buffer layer requires less temperature gradient, and the turbulent core almost no gradient to pass heat at the same rate.

Quantitatively, transfer by convection is more difficult to express. We can apply the integrated form of Fourier's equation for conduction, $q = kA(T_w - T_{avg.})/x$, by assuming that substantially all of the temperature drop occurs across the laminar layer. How-





* To meet your authors, see *Chem. Eng.*, May 18, 1959, p. 182.

Use These Correlations to Find Convection Heat Transfer Coefficients—Table I

	Conditions	General Form
No Phase Change: Fluid Inside Conduit		
Turbulent flow		
Eq. (A)	$N_{Re} > 2{,}000$ $0.7 < (C\mu/k) < 120$	$\frac{hD}{k} = a\left(\frac{DG}{\mu}\right)^{b}\left(\frac{C\mu}{k}\right)^{m}$
	$L/D > 50$ $\mu/\mu_{water} < 2$	$\frac{h}{CG} = a\left(\frac{DG}{\mu}\right)^{b'}\left(\frac{C\mu}{k}\right)^{m'}$
Eq. (B)	$N_{Re} > 10{,}000$ No restriction on viscosity. Otherwise same as Eq. (A).	$\frac{hD}{k} = a\left(\frac{DG}{\mu}\right)^{b}\left(\frac{C\mu}{k}\right)^{m}\left(\frac{\mu}{\mu_w}\right)^{e}$
Eq. (C)	Liquid metals only.	$\frac{hD}{k} = a + b\,(N_{Re}\,N_{Pr})^{e}$
Streamline flow		
Eq. (D)	$N_{Re} < 2{,}000$	$\frac{hD}{k} = a\left(\frac{wC}{kL}\right)^{b}$
Eq. (E)	Limiting case of Eq. (D) when: $T_{out} = T_{wall}$	
Streamline flow and natural convection		
Eq. (F)	$N_{Re} < 2{,}000$ Low viscosity or high ΔT or both. Coefficient a varies with tube orientation and whether fluid is heated or cooled.	$\frac{hD}{k} = a\left[\frac{wC}{kL}\,(1 + bZ^{c})\right]^{1/3}$ $Z = \frac{D}{L}\left(\frac{L^3\rho^2 g}{\mu^2}\right)\left(\beta\Delta T\right)\left(\frac{C\mu}{k}\right)$
No Phase Change: Fluid Outside Conduit		
Normal to single tube		
Eq. (G)	$50 < (D_o G/\mu) < 10{,}000$	$\frac{hD_o}{k} = b\left(\frac{D_oG}{\mu}\right)^{a}\left(\frac{C\mu}{k}\right)^{m}$
Normal to tube bank		
Eq. (H)	$D_o\,G_{max.}$ Note: Constant 0.33 changes with number of rows of tubes in the bank and with their arrangement. $G_{max.} = w/S_{min.}$ where $S_{min.}$ is based on clearance between tubes.	Same as Eq. (G)
Normal to exchanger bundle		
Eq. (I)	Transverse-baffled bundle. Note: Constant a depends on exchanger design. See Donahue, *Ind. Eng. Chem.*, **41**, 2499 (1949). $G_{avg.}$ is the average of $G_{max.}$ as defined in Eq. (H) and G in the baffle opening parallel to the tubes.	
Natural convection		
Eq. (J)	$10^9 < Z < 10^{12}$ Note: Constant a depends on shape and orientation of surface and direction of transfer. Value of 0.13 applies to vertical planes and cylinders.	$\frac{hL}{k} = aZ^{b}$ where: $Z = \left[\left(\frac{L^3\rho^2 g}{\mu^2}\right)\left(\beta\Delta T\right)\left(\frac{C\mu}{k}\right)\right]^{b}$

Specific Correlation
$\frac{hD}{k} = 0.023\left(\frac{DG}{\mu}\right)^{0.8}\left(\frac{C\mu}{k}\right)^{1/3}$ $\frac{h}{CG} = 0.023\left(\frac{DG}{\mu}\right)^{-0.2}\left(\frac{C\mu}{k}\right)^{-2/3}$
$\frac{hD}{k} = 0.023\left(\frac{DG}{\mu}\right)^{0.8}\left(\frac{C\mu}{k}\right)^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}$
$\frac{hD}{k} = 7.0 + 0.025\left(\frac{DGC}{k}\right)^{0.8}$
$\frac{hD}{k} = 2.0\left(\frac{wC}{kL}\right)^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}$
$\frac{hD}{k} = \frac{2wC}{\pi kL}$
$\frac{hD}{k} = 1.75\left(\frac{\mu}{\mu_w}\right)^{0.14}\left[\frac{wC}{kL}(1 + 0.015\,Z^{1/3})\right]^{1/3}$ $\frac{hD_o}{k} = 0.60\left(\frac{D_oG}{\mu}\right)^{0.5}\left(\frac{C\mu}{k}\right)^{0.31}$
$\frac{hD_o}{k} = 0.33\left(\frac{D_oG_{max.}}{\mu}\right)^{0.6}\left(\frac{C\mu}{k}\right)^{1/3}$
$\frac{hD_o}{k} = a\left(\frac{DG_{avg.}}{\mu}\right)^{0.6}\left(\frac{C\mu}{k}\right)^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14}$
$\frac{hL}{k} = 0.13\,Z^{1/3}$

ever, use of this equation to analyze observed performance data shows that the effective film thickness x is in the order of 0.01 in. Assuming that the laminar layer contained all the resistance and its extent can be determined, its value is not of a magnitude that can be measured or used with any accuracy.

Consequently, a more feasible approach is either to predict film thickness or to circumvent it entirely. In practice, the conventional technique is to correlate the single term h which replaces the k/x term in Fourier's equation. By definition, h is the film coefficient of heat transfer and is used in Newton's equation:

$$q = hA(T_w - T_{avg}) \tag{1}$$

Resistances in Convective Heat Transfer

Convective heat transfer seldom takes place through a single substance. Using heat transfer in a heat exchanger as a typical example, we find five thermal resistances in series. These are:

1. Convective resistance for the fluid inside the tube.
2. Resistance of scale and dirt deposits on the inside surface of the tube. While flow through this deposit is by conduction, the thickness of the solid layer is immeasurably thin. Its thickness is commonly expressed in terms of a convection coefficient.
3. Tube wall resistance which is finite and readily determinable as X/kA_m.
4. Scale or dirt deposits of the same nature as in 2 but on the outside surface of the tube.
5. Convective resistance for the fluid outside the tube.

Convective resistance is, by definition, equal to the ratio of temperature difference and heat flow rate, and is the reciprocal of the hA product. For the steady state, heat flows at the same rate through all resistances in series. Hence,

$$\begin{aligned} q &= h_{fi}A_i\,\Delta T_{fi} = h_{si}A_i\,\Delta T_{si} = (kA_m/X)\,\Delta T_m \\ &= h_{io}A_o\,\Delta T_{fo} = h_{so}A_o\,\Delta T_{so} \end{aligned} \tag{2}$$

Since $\Sigma\,\Delta T = T_1 - T_2$,

$$q = (T_1 - T_2)/\Sigma R \tag{3}$$

From Eq. (3), we can define an over-all coefficient of heat transfer.

$$\begin{aligned} \Sigma R &= 1/UA \\ &= 1/h_{fi}A_i + 1/h_{si}A_i + X/kA_m + 1/h_{fo}A_o + 1/h_{so}A_o \end{aligned} \tag{4}$$

such that

$$q = UA(T_1 - T_2) \tag{5}$$

Eq. (5) is an alternate form of Eq. (1).

Much of the early heat transfer literature consists of case histories which report over-all coefficients for specific systems. Today, we follow a more fundamental approach. Heat transfer data supply generalized correlations for individual coefficients. We'll consider only the latter in this article.

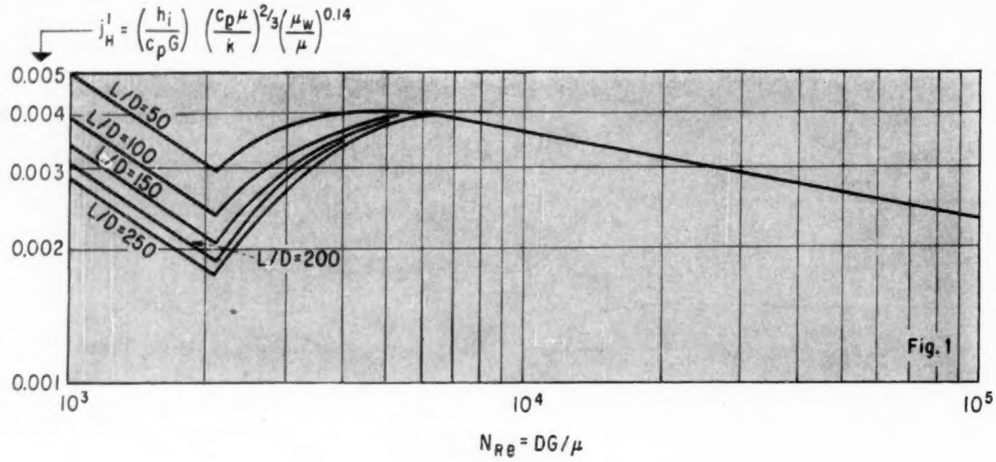
As shown in Table I, we must consider many different cases for individual film coefficients. Magnitude of the coefficient varies with the case considered and with the specific fluid involved.

However, to facilitate our discussion and use of these correlations, we'll examine two categories:

1. Coefficients for fluids which do not change phase.
2. Coefficients for fluid which vaporize or condense.

Each of these may be further categorized as to whether flow is turbulent or laminar and the direction

Chart Gives Heat Transfer Relation for Transition-Flow Region



of flow. Direction of flow may be normal or parallel to the surface. In certain situations, tube orientation, horizontal or vertical, influences the heat transfer coefficient. Let's look at some of the more common correlations.

Our most frequently occurring case is that of a fluid flowing without phase change in forced convection. Here, flow is due to mechanical forces which may be differences in pressure or elevation, or those resulting from pump work. Compare forced convection to free or natural convection in which the flow results from density gradations corresponding to differences in temperature at various points in the fluid.

If the fluid is relatively nonviscous and if the flow is turbulent and inside a circular pipe, the most accepted correlation[8] is of the form:

$$\frac{hD}{k} = 0.023\left(\frac{DG}{\mu}\right)^{0.8}\left(\frac{C\mu}{k}\right)^{1/3} \tag{6}$$

Dividing Eq. (6) by DG/μ and $C\mu/k$ gives:

$$\frac{h}{CG} = \frac{0.023}{(DG/\mu)^{0.2}(C\mu/k)^{2/3}} \tag{7}$$

All numerical constants and exponents in these correlations are empirical. Different investigators have reported different values for the constants and exponents. However, all sets of constants give substantially the same value of the heat transfer coefficient which appears to be accurate to ± 10 to 20%.

Dimensional Analysis Correlates Data

This well-established practice of grouping terms with a common exponent is the end result of dimensional reasoning as well as a convenient presentation for quantitative information. Dimensional analysis[8] is one method of treating complex physical situations in which there is no obvious theoretical relation between quantities such as in heat transfer, in mass transfer and in several other commonly occurring phenomena in chemical engineering.

Dimensional analysis begins with a qualitative statement. In this case, we may say that the film coefficient of heat transfer depends on D, V, ρ, μ, C and k. In the absence of other guidance, this function can be expressed as a power function:

$$h = \alpha D^a V^b \rho^c \mu^d C^e k^f$$

The procedure that is then followed is to write each of these in terms of the fundamental dimensions of mass, length, time and temperature. Diameter has dimensions of length L, whether expressed in feet or in centimeters; density is mass/volume or M/L^3 dimensionally; specific heat is energy per unit mass and temperature difference or, since energy is force times distance or mass times acceleration times distance, ML/θ^2; C has the net dimensions $L^2/\theta^2 T$.

Mathematical equations of exponents, as is required for dimensional agreement of the two sides of the equation, result in a group of equations, one for each dimension. Each equation involves the unknown exponents a, b, c, d, e and f. Solving these equations eliminates a number of the unknowns—in rare cases, all—and establishes the relationship that they must bear to each other.

The resultant expression may include numerical or algebraic exponents or both. Typical examples are $h^1\ D^1/k^1$, $D^b\ V^b\ \rho^b/\mu^b$ or $(V^2\rho D/\sigma)^m$. In all of these groups, the component quantities are so combined as products and quotients that the group is dimensionless. A number of the groups have physical significance. For example, if hD/k is rewritten as $h(D/x)/(k/x)$ where x is the ficticious film thickness, the quantity becomes $h(D/x)/h$ or simply D/x. This group is known as the Nusselt number which is the ratio of pipe diameter to effective film thickness.

Recognition of the principle that the value of the group is significant rather than that of the individual quantities which comprise it can greatly facilitate the conduct of experimental investigations and the correlation of the resulting data. Another advantage is the use of any convenient units as long as they are con-

sistent. Finally, the arithmetic manipulations are simpler and quicker to carry out than they would be if the heat transfer coefficient were expressed as a dimensional equation. Hence, a dimensional form of the general equation is:

$$h = 0.023D^{-0.2}V^{0.8}\rho^{0.8}\mu^{-0.467}C^{1/3}k^{2/3} \quad (8)$$

Correctly used, Eq. (6), (7) and (8) give the same value of h. Since the constants are empirical, the equation is valid only for the conditions under which these were evaluated.

In addition to the requirement of turbulent flow (Reynolds number greater than 2,000) and of nonviscous fluids (arbitrarily defined as a viscosity not greater than twice that of water at the same temperature), correlations of this form are subject to these additional limitations: $L/D > 60$ and $0.7 < (C\mu/k) < 120$. Note that a more realistic criterion for viscosity might be the rate of change of viscosity with temperature.

The next correlation[4] we will consider is the widely used Sieder-Tate equation:*

$$\frac{hD}{k} = 0.023\left(\frac{DG}{\mu}\right)^{0.8}\left(\frac{C\mu}{k}\right)^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14} \quad (9)$$

This equation is applicable to fluids of any viscosity. It was derived from data in which the Reynolds number was 10,000 or higher. Consequently, it is considered reliable only above this minimum value. Otherwise, the restrictions just enumerated for Eq. (6) apply. Note that Eqs. (6) and (9) differ only in that Eq. (9) includes the term $(\mu/\mu_w)^{0.14}$. This group accounts for the change in viscosity of the fluid over the temperature range to which it is subjected.

Variation in viscosity can alter the effective thickness of the film when the tubeside fluid is being heated at a given velocity, the average temperature of the film is greater than that of the bulk of the fluid. Thus its viscosity is less and the film is thinner than predicted on the basis of the properties at the bulk temperature. In this case, μ/μ_w is greater than one and the coefficient is correspondingly higher. If the fluid had been cooled, the reverse would have been true and this factor would have predicted a lower value for the coefficient.

As shown in Table I, comparable equations exist for other flow situations such as flow normal to a single pipe, to banks of pipes and to tube bundles.

Correlations for Low Reynolds Numbers

When the Reynolds number is less than 2,000 for gases and relatively nonviscous liquids or less than 10,000 for liquids twice as viscous as water, we cannot apply these correlations. For Reynolds numbers below 2,000, where flow is laminar, Eqs. (10) and (11) are recommended. Eq. (10) is unique in that its form and, to a large extent, the constants are consistent with the theoretical equation first proposed by Graetz.[5]

$$\frac{hD}{k} = 1.86\left(\frac{wC}{kL}\right)^{1/3} \quad (10)$$

* The constant 0.023 in Eq. (9) was originally reported as 0.027. Experimental results showed both positive and negative deviations from the line representing this equation. Use of the lower value is recommended as conservative design practice. Any deviation between the predicted value and that actually occurring will be on the safe side and the unit will give, at least, the expected performance.

More recent data and the desirability of predicting different values for heating and cooling led to the improved version:

$$\frac{hD}{k} = 2.0\left(\frac{wC}{kL}\right)^{1/3}\left(\frac{\mu}{\mu_w}\right)^{0.14} \quad (11)$$

This equation can also be modified to allow for natural convection effects and for the close approach of the fluid outlet temperature to that of the wall. Eqs. (E) and (F) in Table I cover these cases.

Pipe length L which does not appear in the turbulent flow correlations is needed in streamline flow to account for entrance effects and the fact that the coefficient is higher at the inlet end of the tube. At the entrance, the coefficient is higher because the tempera-

Nomenclature

A Heat transfer surface, sq. ft.
C Specific heat, Btu./(lb.) (°F.).
D Pipe diameter, ft.
G Mass flow rate, lb./(hr.) (sq. ft.).
g Acceleration of gravity, ft./sec.²
h Film coefficient of heat transfer, Btu./(hr.) (sq. ft.) (°F.).
j Heat transfer factor, dimensionless.
k Thermal conductivity of fluid, Btu./(hr.) (sq. ft.) (°F./ft.).
L Pipe length, ft.
L_H Heated length, ft.
Q Quantity of heat, Btu.
q Rate of heat transfer, Btu./hr.
R Thermal resistance, $1/hA$ or X/kA_m.
S Flow area, sq. ft.
T Temperature, °F.
U Over-all coefficient of heat transfer, Btu./(hr.) (sq. ft.) (°F.).
V Velocity, ft./hr. or ft./sec.
v Volume, cu. ft.
w Weight rate of flow, lb./hr.
X Length of path for heat flow in conduction, ft.
x Effective film thickness, ft.
β Coefficient of thermal expansion, 1/°F.
Γ Weight rate of condensate drainage from vertical tube, $w/\pi D$, lb./(hr.) (ft.).
Γ' Weight rate of condensate drainage from horizontal tube, w/L_H, lb./(hr.) (ft.).
ΔT Temperature difference.
θ Time, hr.
λ Latent heat of condensation, Btu./lb.
μ Viscosity of fluid, lb./(hr.) (ft.) or lb./(sec.) (ft.).
ρ Fluid density, lb./cu. ft.
σ Surface tension, lb. force/ft.

Constants, dimensionless

$a, b, c, d, e, f, m.$

Subscripts

a.m. Arithmetic mean value.
f Film.
i Based on inside pipe diameter or area.
l.m. Logarithmic mean value.
m Mean value.
o Based on outside pipe diameter or area.
s Scale.
w At surface of wall.
1 Position along path of heat transfer, usually at highest temperature.
2 Position along path of heat transfer, usually at lowest temperature.

ture is uniform whereas further away definite temperature and velocity distributions have been established. It is the length of pipe section between points at which the fluid is mixed to a homogeneous temperature. In a conventional multipass exchanger, it corresponds to the length per tube.

Theoretically, this equation gives a coefficient which should be used with the arithmetic mean temperature difference. However, in practice its use with a logarithmic mean temperature difference will avoid the chance of obtaining impossible answers such as an outlet temperature higher than the wall surface from which the fluid is receiving heat. This result may be predicted when using the arithmetic mean value for those cases where the outlet fluid temperature approaches the surface temperature.

In the transition region, a mixture of streamline and turbulent flow exists. The fluid may be laminar for a finite distance from the wall and turbulent in the center. Since this is not necessarily reproducible, much less quantitatively predictable, the usual recourse is to use empirical data plots. To make these as general and as usable as possible, the usual graph shows a j factor as a function of Reynolds number. A typical plot[7] is shown in Fig. 1. While such a plot is essential for the transition region, it is also a convenient method of handling laminar and turbulent conditions. For these it is a graphical solution of Eq. (9) and Eq. (11). A similar plot replaces Eq. (H) for shellside flow.

Film Coefficients for Phase Changes

In the present state of our knowledge of heat transfer coefficients, the cases of condensing vapors and boiling liquids present a distinct contrast. On the one hand, the fundamentals of condensation have been firmly established and workable equations have been derived. The major frontiers in this area lie in mixtures and other variations of the basic problem.

In comparison, the literature on boiling consists, primarily, of numerous case histories. Only recently have articles presented the results of research into fundamentals which should ultimately lead to satisfactory generalizations. At the present time, the soundest designs are based on empirical data obtained for the specific material under the exact conditions at which the data are to be used.

For condensation, the basic equations are derived from Nusselt's work.[8] Based on his analysis and mathematical treatment, these equations can be written in several forms as best suit the information available. Condensation on vertical pipes:

$$h = 0.925k_f(\rho_f^2 g/\mu_f\Gamma)^{1/3} \quad (12)$$

$$h = 0.943(k_f^3\rho_f^2 g\lambda/L\mu_f\,\Delta t)^{1/4} \quad (13)$$

$$h = 1.47(k_f^3\rho_f^2 g/\mu_f^2)^{1/3}/(4\Gamma/\mu_f)^{1/3} \quad (14)$$

Condensation on horizontal pipes:

$$h = 0.953k_f(\rho_f^2 g/\mu_f\Gamma')^{1/3} \quad (15)$$

$$h = 0.725(k_f^3\rho_f^2\lambda g/D\mu_f\,\Delta t)^{1/4} \quad (16)$$

$$h = 1.51(k_f^3\rho_f^2 g/\mu_f^2)^{1/3}/(4\Gamma'/\mu_f)^{1/3} \quad (17)$$

In all of these equations, the coefficient is an average value applicable to the entire surface on which condensation takes place. All of the thermal resistance is assumed to lie in the condensate layer. This layer varies in thickness and thus causes a corresponding variation in the point value of the coefficient.

Nusselt's derivation excludes any vapor phase resistance. It assumes that the condensate drainage from the surface is due to gravity alone without any drag effects caused by vapor flow, and at a rate such that flow is laminar. Since this last assumption must be verified, Eqs. (14) and (17) are recommended.

The groups $(4\Gamma/\mu_f)$ and $(4\Gamma'/\mu_f)$ are the Reynolds numbers for the condensate flow from vertical and horizontal tubes respectively. These must be below specific values for the flow to be laminar. Based on observed coefficients, turbulence seems to be present beginning at 1,200 in the former case and, possibly, as low as 200 in the latter.[11] These values of the Reynolds number are frequently attained in practice for vertical pipes. For these, Kirkbride's equation[9] gives more reliable results:

$$h = 0.0077(k_f^3\rho_f^2 g/\mu_f^2)^{1/3}\times(4\Gamma/\mu_f)^{0.4} \quad (18)$$

For horizontal condensers, the critical Reynolds number is seldom reached because Γ', weight of condensate per unit of pipe length, is usually much smaller than Γ, weight of condensate per unit of pipe circumference. Hence, turbulence due to high Reynolds number is not a major factor in horizontal units.

Application or modification of these basic equations are discussed in the literature. Consult the reference cited for the special conditions where velocity is a factor,[10] or where mixtures of vapors are condensed giving a condensate which either separates into immiscible layers[12] or remains miscible,[11] or where only one component condenses from the vapor at the operating conditions.[13]

Boiling Coefficients

Correlations for boiling liquids are generally for a single material being vaporized under specific conditions. Factors which have a strong influence on the boiling coefficient are: material of construction for heating surface, its age and cleanness and its shape and orientation. Nukiyama[14] demonstrated the different mechanisms by which vaporization can occur and his work has done much to facilitate correlation. The more recent work of Roshenow,[15] and Westwater[16] has delineated major factors affecting these relations.

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Consider all Factors in a . . .

Rational Approach to Plant Layout

Donald Thompson, Engineer and Architect, Darien, Conn.

YOU can't build a plant just from its layout. It doesn't tell you how to build; it's the framework on which to build the actual construction drawings and details. Just the framework—the pattern—doesn't sound like much but it may be the single most important step in the economical construction and operation of a new chemical plant.

All this must be done early in the game. You must establish a fixed layout that's dependable and accurate. This series will take you through the fundamentals of plant layout in an effective step-by-step method.

The first article in this series (*Chem. Eng.*, Nov. 30, p. 69) dealt with the philosophy of approach and over-all procedures. Now, this second and concluding article will cover particular methods to use in actual plant layout.

Consider Pumps and Pipes

When pumping liquids at or near their boiling point, allow sufficient suction head to prevent flashing at the pump. Examples are the bases of distillation columns and condensate receivers. For typical process pumps and fluids, this may run from 8 (seldom less) to 16 ft. (sometimes more).

When you have a gravity return from an overhead condenser, make sure you allow sufficient head to balance the pressure drop through the overhead condenser, separator and piping.

Remember to correct for specific gravity at operating temperature. In all vertical pipelines that maintain pressure differences by liquid columns, pressure varies as the specific gravity. Systems calculated for water will fail with a less dense liquid. Temperature may lower specific gravity appreciably, particularly with high-boiling liquids.

Because of the greater head involved, this is particularly pertinent to barometric legs between condensers operating under vacuum and condensate receivers at atmospheric pressure.

Equipment Fixes Floor Height

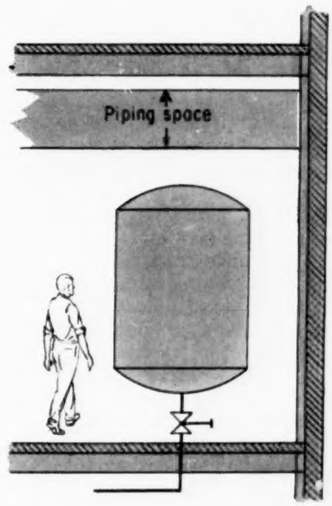
Heights vary from 14 to 20 ft. for typical process plants (not offices, etc.). This is generally determined by equipment, and particularly by tanks.

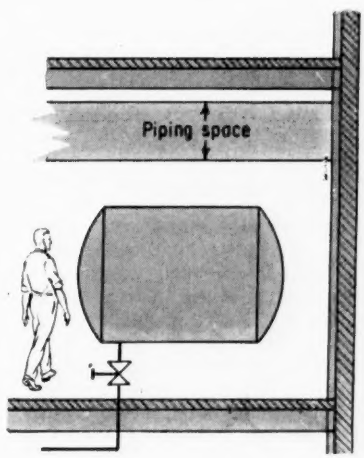
To accommodate piping and permit valve access, floor-to-floor heights, must generally be 8-10 ft. more than the straight-side height of vertical tanks with dished ends.

Horizontal tanks take less floor height but at the expense,

Headroom for Example

Horizontal tanks take up less floor height but at the expense of floor space. You must choose which factor is more important in your layout.





Proper Sizing of Bays Helps Open Up Layout

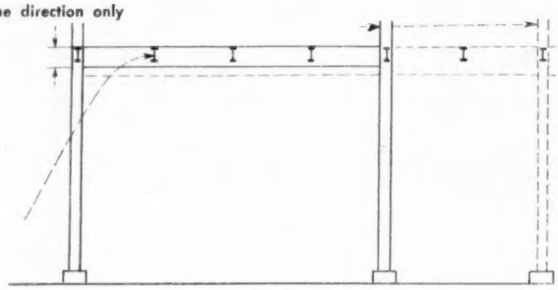


Fig. 1

of course, of more floor space. You must make this choice depending on your requirements.

All Buildings Have Stairs

There's a certain amount of empiricism in establishing floor heights and you can't define them accurately within the height of a stair riser. Since stairs are an inevitable part of all buildings and structures, it's convenient to establish floor heights as a multiple of a standard riser.

A convenient basis for preliminary planning of stairs is: 3 risers = 2 ft.; 5 treads = 4 ft.

To avoid fatigue, don't have any single flight of stairs exceeding 18-20 risers; beyond this, use two or more flights or an intermediate landing.

There's really no reason, either physiological or construction, why chemical process plants can't standardize on the 8 by 9½-in. or 8¼ by 9 in. stair.

How to Pick Bay Sizes

For typical process plant loadings, a 20 by 20-ft. bay is an economical norm. Increasing one direction only results in a minor increase in steel since only the girders in the long directions are increased—depth of framing in the other direction remains the same.

This way, columns are more effectively loaded and although their weight goes up, their number goes down.

Here is an extremely useful opportunity to open up the layout with a minor increase in cost. Since most plants tend to align in rows in one direction, widening the span crosswise to the long axis provides space where it's needed.

Set Construction Details

During the early planning stages, building construction details aren't often completely established. The following information is sufficient to define the shape of buildings and allocate space to the construction of its components. (Fig. 3, 4).

Walls—Whether you construct walls of masonry or sheet materials, it's generally safe to plan on the outer face of exterior walls being 12 in. from the center line of adjacent steel framing.

Interior walls and partitions often serve as fire walls or barriers. Therefore, during the early stages, plan on making these 8 to 12-in. thick.

Floors—Process plant buildings and structures generally have floors of either steel (checker plate or grating) or concrete.

Before planning has gone too far, it's possible to make a basic determination between these two types, possibly on the basis of past practice. Assume a 6-in. thickness where you use concrete (slabs rarely exceed this). For preliminary planning with steel flooring, consider thickness as negligible.

Roofs—If equipment (such as condensers, etc.) is placed on a roof, assume a 6-in. thick concrete slab. If the roof isn't load-bearing, the deck usually runs 2 to 4-in. thick.

Doors and Windows — Single doors are pretty well standardized at 3 by 7 ft. Common sizes for double doors are 5, 6 and 8-ft.

Sliding and rolling doors are available in any required size, usually standardized in 1-ft. multiples.

The largest openings are often closed by accordion (multi-leaf) doors.

Mind this precaution: Always indicate (and leave room for) doors in the open position, and the swing required to reach it. Have door swings in the direction of escape or exit.

With windows, there's little restriction presented at the prelimi-

Use These Standards for Proportioning Stairs

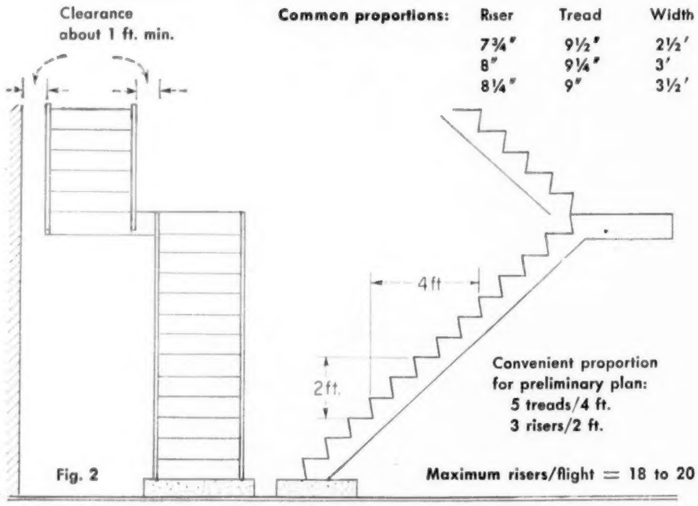


Fig. 2

nary planning stage except for the clearance required for open ventilating sections; this sometimes restricts the placing of adjacent piping.

Provide for Access and Escape

Access and escape is required for normal operating surveillance, maintenance and safety.

Underlying all other factors is the general principle that every operating area must have at least two means of access and escape. Locate these, as far as possible, at each end, to prevent being trapped with a hazard blocking an escape route.

Exception is usually made for areas less than about 500 sq. ft. and single bays where the distance to a single escape exit is short.

Operating areas of intermediate size justifying two means of escape are often provided with one stair (for normal operating access) and one ladder.

Stairs vs. Ladders—Where access to an upper area is required as a part of normal operating surveillance, you should provide stairs. Where access is required only for maintenance, or where operating attention is infrequent, ladders are usually acceptable.

On any upper area, limit the distance to a stairway at 40 to 50 ft. and provide intermediate stairs where necessary.

Use These Distances for Safety Clearance

Presence of Flammable	Ignition Source	Clearance, Ft.
Constant	Constant	75–100
Intermittent	Constant	50– 75
Constant	Intermittent	50
Intermittent	Intermittent	40– 50
From storage	To process	75–100

Application of stairs and walkways to typical processing areas is shown in Fig. 7.

Allow for Clearance

Space is valuable and clearances between sections of the plant expensive. How expensive depends, in part, on whether your plant is located in open country or in a built-up metropolitan area. In either place, there's a certain amount of give-and-take in establishing clearances. The following information is intended to establish general limits.

There are two main kinds of clearances required: for safety and for maintenance. Fortunately, the clearance necessary for safety is usually more than enough for maintenance.

Safety Clearances—Main principle is separating sources of ignition from sources of flammables (generally vapors).

When you have the situation where the sources of both ignition and flammables occur constantly, you need maximum separation.

When the occurrence of either is intermittent, the likelihood of one reaching the other is less. Therefore, less separation is required.

Examples of constant and intermittent sources of each are:

- Constant ignition: furnaces, open slip-ring motors.
- Intermittent ignition: switch rooms, control rooms (based on intermittent electrical contactors).
- Constant flammables: pump glands, continuous vents.
- Intermittent flammables: closed equipment and piping systems.

In the table on the left are shown distances for safety clearance that represent both minimum and good practice. These are based on the absence of low points between the two sources in which flammable vapors can collect, such as trenches, pits and the confined spaces within dike walls.

Basis for the clearance when the

Set These Construction Details in the Early Planning Stages

Floor: cross section

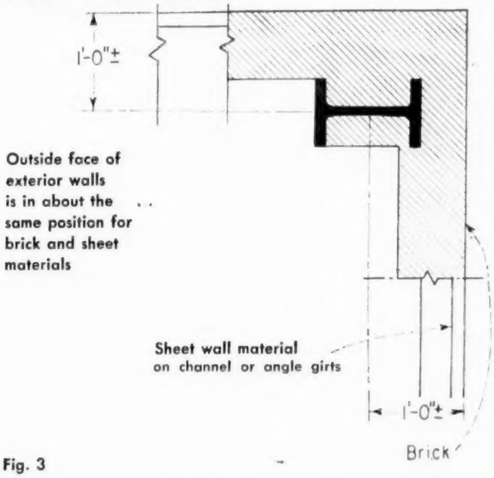


Fig. 3

Wall: plan

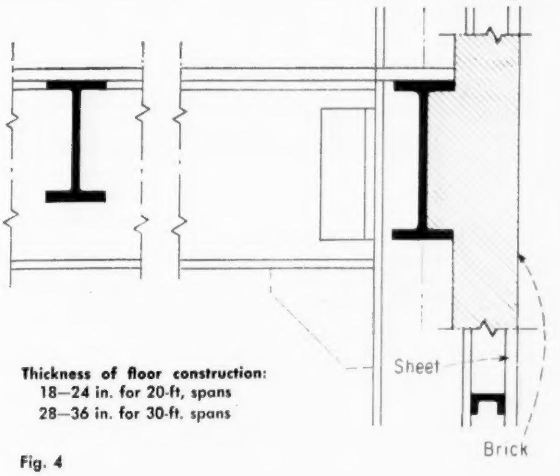


Fig. 4

Allow for Clearance

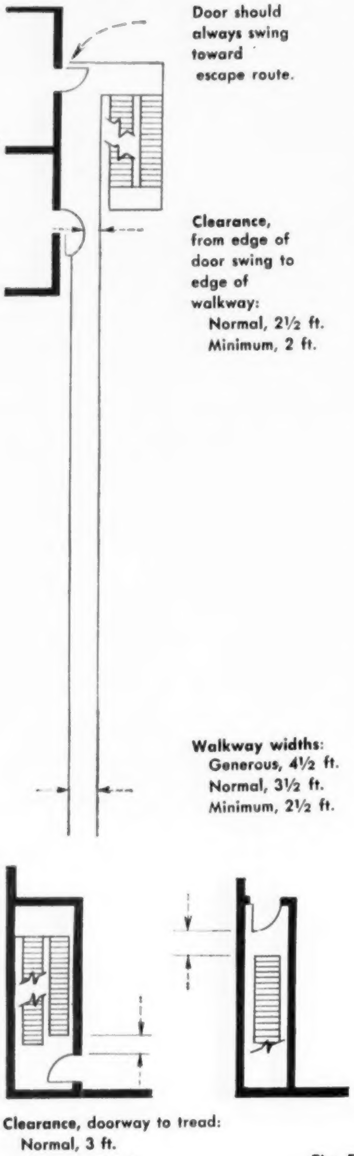


Fig 5

presence of both flammable and ignition is intermittent, is the unlikelihood of both a leak and a source of ignition occurring simultaneously; also, that there's a further unlikelihood of any particular leak reaching a particular ignition source.

So-called "pressurizing" of switch and control rooms, to exclude possible flammable vapors, further reduces the probability of ignition.

A special case exists when storage is the source of the flammable. This is based on the principle of separating large-volume storage with low chance of ignition from the process unit in which over-all accident liability is greater.

For a more detailed analysis of safety clearances, consult the API's "Code of Recommended Practice RP-500."

Maintenance Clearance—The only way you can economically justify maintenance clearance is in terms of the relative size of the equipment served. For example, the range of sizes for chemical plant equipment is generally smaller than refinery equipment.

Much of the equipment normally handled in a refinery by a crawler or truck crane is handled in a chemical plant by chain hoists into dollies.

Here's the approach: Classify equipment broadly by the handling required for its maintenance.

- Major maintenance serviced by portable crane handles equipment such as towers, reactors, tanks, etc. —In general, assume you can't remove these units and they, therefore, must be repaired in place. Requirement: crane access.
- Medium maintenance serviced by portable crane: exchangers, large pumps, receivers and small tanks, etc.—This type of equipment is removed as a unit or part of a unit such as an exchanger bundle. Again, the requirement is one of crane access. If on an elevated structure, check the accessibility of boom and the capacity as extended.
- Medium maintenance serviced by permanent lifting frames: exchangers, agitators, internal coils and fittings, etc.—Area from equipment location through the route it will take to truck or other removal is the clearance requirement.
- Minor maintenance lifted by hoist from above, removed on dolly: pumps, smallest vessels, etc.—Here you need clear aisle space for dolly access.

Compressors, as an exception, are handled by permanent overhead traveling cranes, or monorails over cylinders or rotors.

Design Flexibility In

A good layout is flexible. This means it's designed to accommodate change. Process improvement is constant and you should always be able to make necessary changes without disrupting the plant.

Typical changes suggested by process improvement studies are such additions as:

- Exchangers, to improve heat recovery, increase yield or correct for inadequate initial design.
- Separators, to improve flow, and receivers to provide desirable holdup, treatment or measurement.
- Pumps, to handle an additional process stream.
- Instruments and control valves, to make automatic what was previously manual or uncontrolled.
- Piping alterations, associated with all changes.

You can sometimes foresee the possibility of an additional future piece of equipment during original design, an additional cut tank, for example, on a batch still. In such cases, leave space for the additional item, showing it on the layout. This insures available space and even, perhaps, structural supports.

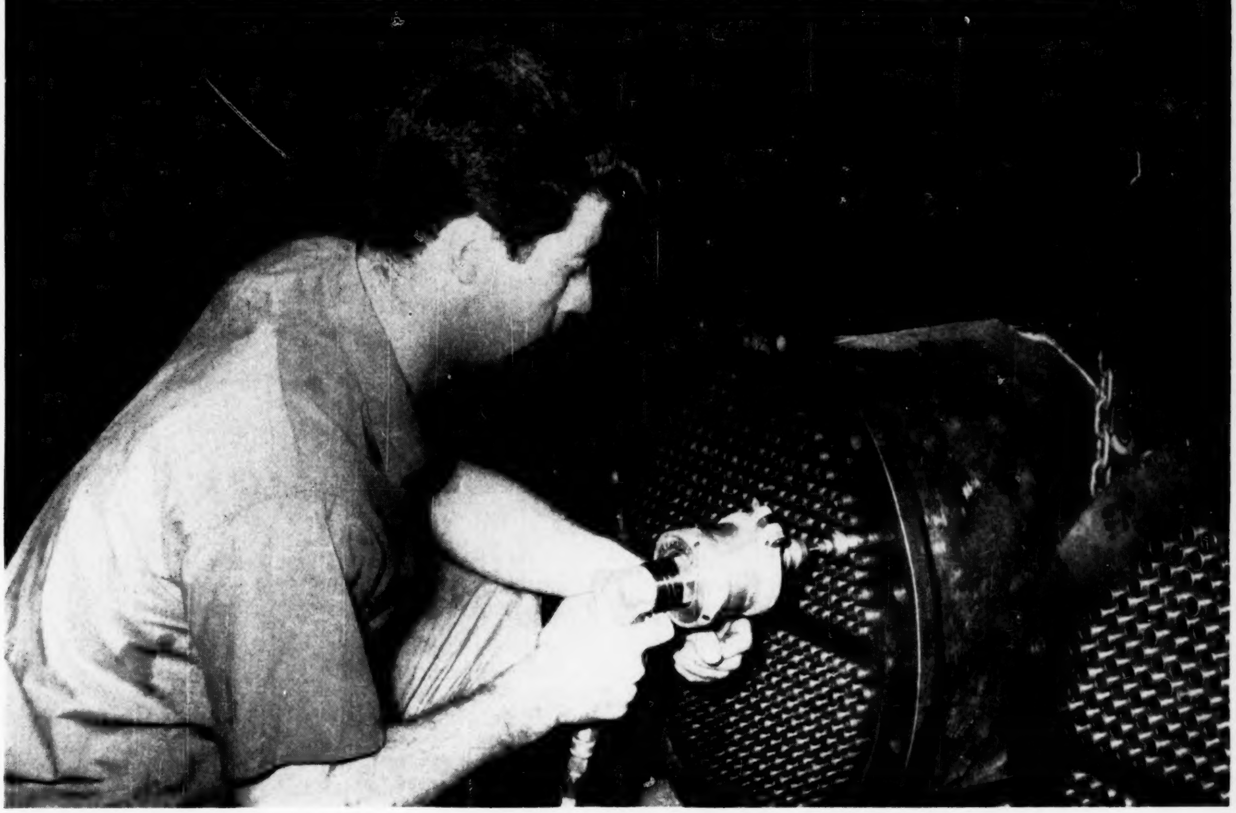
Another kind of flexibility that good layout includes is provision to extend the plant. In an expanding economy, success in the operation of a new plant is usually followed, sooner or later, by an increase in the market for its product. Ability to provide for this increase should, therefore, be recognized in layout of the initial plant.

Experience in the expansion of chemical production teaches, however, that plant expansion seldom repeats the identical processing scheme of the original. To do so, denies the possibility of process improvement; a highly unlikely situation in the proliferating and competitive chemical industry.

Conclusion drawn from this is: Plant layout should always permit expansion, in ways not just limited to repeating the original plant but, with minimum restriction to the nature of the additions.

You can accomplish this best by providing space for extension in a rational manner for the major elements of the layout: structure, areas reserved to large free-standing equipment (towers and reactors) segregated tank areas, pump alleys and exchanger tanks.

In practice, providing for extension often reduces to a simple rule: Don't place equipment at the ends of process structures and areas. This allows you to extend as much or as little as the future may prescribe.



Rolling and Retubing Gives You . . .

Longer Life for Heat Exchangers

This is the second and concluding article in a series of two giving the whole story on the mechanical maintenance of heat exchangers.

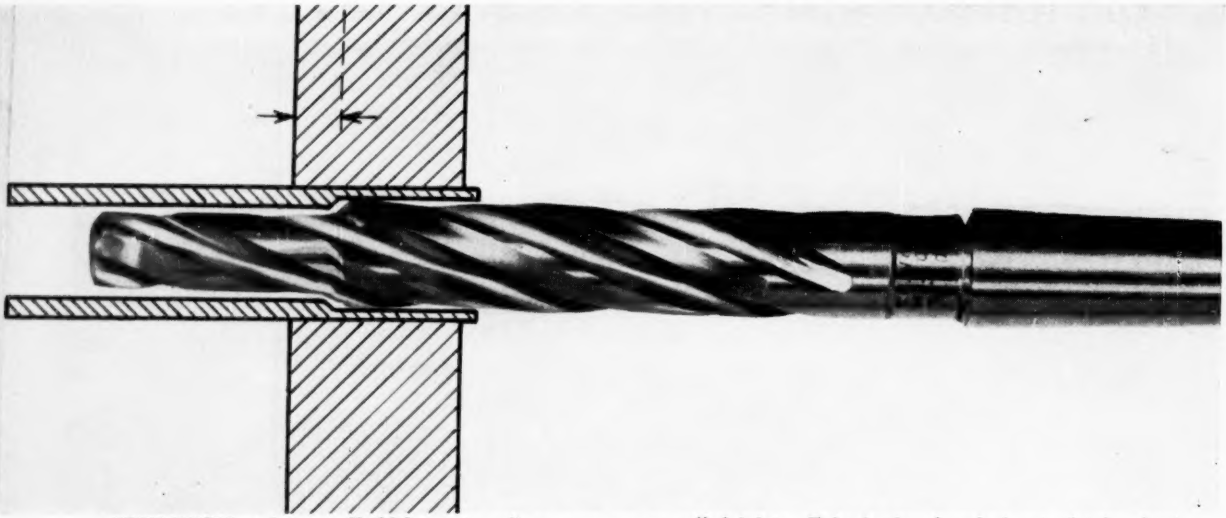
A. JOHN, Assistant General Manager, Thomas C. Wilson, Inc., Long Island City, N. Y.

BASICALLY speaking, extreme care is necessary to obtain optimum reliability of a rolled tube joint. If a job is started right, it will turn out right. Although time, reduced to cost is important, no heat exchanger is any better than its rolled joint.

Properly rolled joints should have uniform tightness to minimize tube fractures and stress corrosion; ligament pushover and enlargements; or dishing of a sheet. If tube ends are cold worked to death they will most certainly leak, and no amount of rerolling will tighten them.

Today's high-pressure heat exchangers are particularly vulnerable and good prescribed methods and tools are an absolute necessity. Skill is also vital so assign only trained personnel to this type of work.

Assembly of tube to sheet is a frictional-mechanical type of joint (unless welded) and you must ex-



STEP DRILL reduces wall thickness to relieve pressure on rolled joints. Tube is then knocked out of tube sheet.

ercise extreme care in all stages of performance.

Start With Tube Removal

Before tubes are replaced, you must properly remove the existing ones. There are many methods for doing this, but they fall into two general classes depending on whether or not the tubes are accessible from the outside of the bundle when removed from the shell.

One method, when a tube is on the outside, or when you are removing all tubes, is to cut the tube at each end just inside the tube sheets; later, removing the stub ends from the tube sheets.

If you can't remove the tube bundle, as when tube sheets are welded into the shell, or if you want to take out only a few tubes in the interior of a cluster, then removal is accomplished entirely through the holes in the tube sheet.

When tubes are accessible, an oxy-acetylene torch is frequently used to cut them back of the sheet or head. This is a rough but passable method. However, it has disadvantages not present if tubes are sawed or mechanically cut.

For one thing, the torch may leave blobs of metal on the stub. This can damage the tube sheet hole during removal of the stub if driven from the inside face. Secondly, burning nonferrous tubes produces objectionable fumes.

Also, you eventually will have to saw the tubes to bring them to length and square their ends if you intend to reuse them. This can be eliminated if the tubes are mechanically cut or sawed accurately during the removal operation.

Some objections also apply to the frequent practice of cutting tubes with an air-hammer chisel. This tool doesn't produce square ends and leaves burrs to damage tube holes.

Smooth and accurate cutting is particularly important if you want to use most or all the removed tubes again in a shorter heat exchanger.

Large shops find it practical to invest in a special horizontal bandsaw for tube cutting. In small shops, or otherwise, an internal mechanical cutter powered by an air motor or electric drill, is good for accurate cutting. This tool is somewhat like a movable fly cutter. It's inserted the proper distance inside the tube and rotated. The cutter expands radially and cuts the tube off clean from inside. With this cutter you can sever a ¾-in. O.D. admirality tube in 3 sec.

Accessibility Affects Technique

When the tubes aren't accessible from outside the bundle, then removal is entirely through the tube hole at the tube sheet.

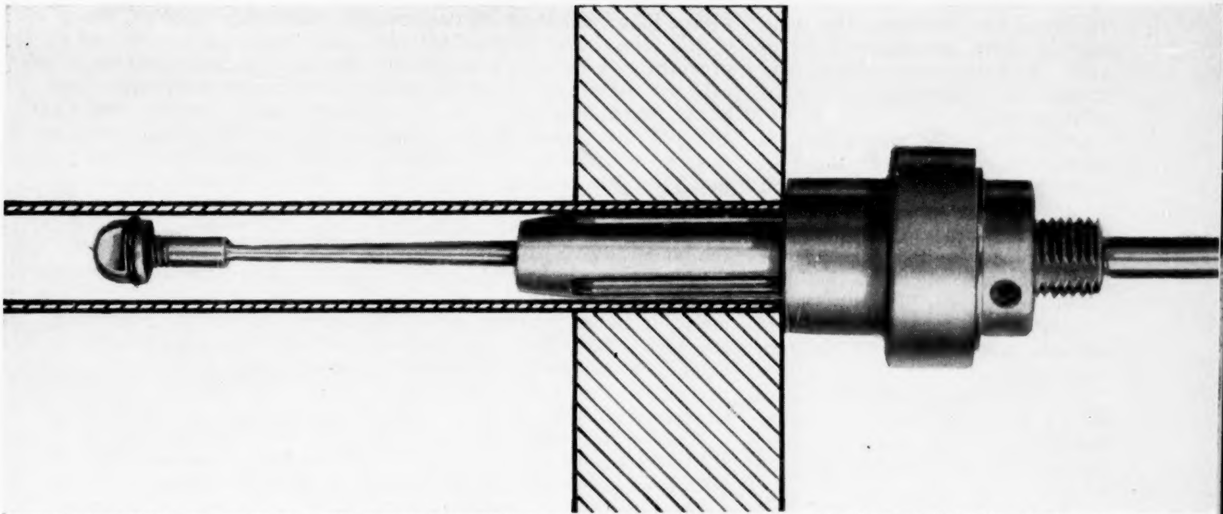
One good method is to drill out the tube, where it's rolled into the tube sheet, with a drill slightly smaller than the tube hole. There must be this difference in diameters as a full diameter drill will drift sideways into the sheet and create an oval hole—most difficult to roll. By using a smaller drill you also prevent the tube from dropping beyond the sheet.

Reducing the tube wall thickness at each end by this drilling method relieves the original expanded pressure established when the tube was rolled. This permits you to pull the tube out through the tube sheet and baffles from either end.

It is best to use a special wall reducing tool, or step drill (shown above) for this purpose. An ordinary drill might drift and damage the hole in the tube sheet since there's nothing to keep it centered. Such damage to the tube sheet hole prevents making a tight joint when rolling in the new tube.

The special tube reducing tool is slightly smaller than the tube O.D. and designed with a cutting pilot. Pilot fits the tube I.D., keeps the tool centered and makes it unnecessary to clean scale out of the tube end before the wall reduction.

Run the drill in far enough to reduce the tube wall for about ¾ of



TUBE ROLLING setup with stop collar and pilot. Collar prevents enlarging tube diameter beyond the tube sheet.

the thickness of the tube sheet, never entirely through the tube sheet. This prevents the tube from breaking off at the back edge of the tube sheet hole. Otherwise, you'll have to go through a fishing operation to bring the tube out through the hole again.

Tube Ends Are Troublesome

When tubes are cut or burned, the butt ends remain in the tube sheet. If they won't budge with a knock-out tool, you can loosen them with the step drill.

A tube collapsing tool, sometimes known as an oyster knife or ripper, will also free the tube ends or remaining butts. It collapses the tube to relieve the rolled-in pressure on the tube sheet hole.

You can use it instead of wall reducing if the gage is thin. For heavy tube gages, the wall is first reduced and then the collapsing tool used, if considered necessary, prior to knock-out or pulling.

Usually, when the wall reducing tool is used first, the collapsing tool isn't needed unless the holes in the tube sheet have been serrated or grooved to provide additional mechanical strength.

Exercise extreme care in using a collapsing tool to avoid damaging the tube sheet hole. Lateral scoring of the hole or forced out-of-roundness or bell-mouthing may prevent successful rolling of a tight joint.

At best, collapsing tools are controversial and it's safe to state that it is an infrequently used method.

Cleaning Is Important

After the tube or tubes have been removed, thoroughly clean the tube sheet holes of oil, scale, etc. This is extremely important since there are indications that oil will fry out or coke and ultimately make a tight joint leak. Expanding wire brushes, used for tube cleaning, are excellent for rapidly cleaning tube holes. They can be mounted to an air or electric drill.

Clean the tubes themselves, or at least the tube ends, inside and out, prior to assembly and ultimate rolling. Dust or scale or other foreign matter prevents smooth rolling and interferes with a tight joint.

You want a smooth rolled finish because it improves flow, and offers fewer opportunities for the start of stress or crevice corrosion or stress cracking.

Then, Tube Expansion

The commonly used type of roller tube expander was patented in 1853. Designers then were ahead of their time since today the only basic changes are in better quality of steel, ball bearing stop collars and self-feeding expanders.

Expander consists of a cage holding a number of rolls held loosely so that they move in and out. A tapered mandrel fits through the center of the cage and bears against the multiple rolls.

In operation, the expander cage is placed in the tube and the mandrel inserted in the cage as far as it will go (above). Then, the mandrel is turned by hand or motor.

Revolving the mandrel in turn rotates the rolls (through friction) which travel around the inside of the tube carrying the cage with them. As the tapered mandrel is fed through the cage it forces the rolls out, causing them to roll and smoothly expand the tube, cold working the metal to a permanent set and a tight fit in the tube sheet. Mandrel is fed through the cage at an angle to the centerline.

Reversing the mandrel's rotation automatically causes the feed to reverse and releases the expander and mandrel from the tube.

For long life and smooth joints always see that the expanders are properly lubricated.

Rolling Must Be Accurate

Precision in rolling joints is vital. Under-rolled joints leak while over-

rolling unnecessarily work-hardens the metal and increases the tendency to stress cracking and corrosion. Extreme over-rolling may conceivably create a loose tube joint as well.

Over-rolling has been known to expand the diameter of the tube sheet to such an extent that it wouldn't fit back in its shell. Moreover, unequal rolling of joints can bow the tube sheet, and push over the bridge or ligament between holes.

Your ultimate goal of course is to roll all tube ends to a uniform tightness.

Some old-time personnel are able to roll tubes to a fairly uniform tightness by feel. Some can gage tightness by the sound of the motor.

This isn't necessarily the best procedure. Torque and the sound an operator reacts to, depend on variables such as air pressure at the motor, mechanical condition of the motor, general noise level in the shop, etc. Fatigue encountered toward the end of the day also affects correctly judging the right feel.

Sometimes rolling is done to a predetermined diameter, or a specific amount of extrusion of the tube, due to wall thickness reduction during rolling. Such methods involve difficulties in measurement and don't necessarily allow for variances in tube sheet hole diameter or variables in gage.

Thus, there's good reason for the growing trend to use motors with automatic torque controls. These pre-sense tightness as expanding proceeds and stop rotation upon reaching a pre-selected torque.

Most accurate of these torque sensing devices measure torque at the mandrel and trip off automatically. Thus absolute uniformity of expansion of all tube ends is assured regardless of variable tube holes.

These controls take all the guesswork out of tube expanding. Many specifications call for controlled rolling as good end results are obtained: No leaks, no overrolling, no ligament pushover and uniform tube tightness. Certainly the major causes of leaking tubes are minimized by using torque controls.

Most heat-exchanger tube sheets are thin enough that a one-step tube rolling method is used.

Stop collar of the expander is set in such a position that the rolls extend to, or just short of, the back of the tube sheet. Stop collars are provided with recesses to automatically set the projection of the tube at the first rolling operation.

Tubes are placed in the sheet flush or with about $\frac{1}{32}$ in. projecting. Then, the expander is inserted until the stop collar is against the tube sheet. Rotation is applied to the mandrel which in turn imparts rotation to the rolls.

As the tube is rolled it's automatically pulled into the recess of the stop collar. Thus the desired amount of projection of the tube, beyond the first tube sheet worked on, is automatically fixed.

Whether the rolls are set inside the back edge of the sheet, or even with it is somewhat subject to disagreement. Either location seems acceptable as long as the tube isn't rolled beyond, or circumferentially marked or scored, by the inside face of the tube sheet. This prevents fracture of the tube, by vibration or other stress, which could occur if the rolls rotated partially outside the tube sheet hole and impressed the sharp corner of the tube sheet hole edge into the tube.

Notwithstanding, fill the tube hole to prevent crevice corrosion that may occur if a small opening is left. Round nose of the expander roll adequately fills the gap.

Also, if rolls extend beyond the tube sheet, a bell or prosser condition might be created preventing eventual pulling of the tube when retubing.

Some evidence indicates a tube need not be rolled for the full thickness of a very thick tube sheet. Normal and average practice is to hard roll the tube up to 3 to 4-in. of a thick sheet and light roll (just to fill the hole) the remaining thickness.

Expansion Is Part of Rolling

Most expanders are made with rolls $1\frac{1}{2}$ or $2\frac{1}{2}$-in. long. If tube sheets are thicker, more than one rolling operation is necessary. A long reach expander is used for step rolling and the tube is first rolled at the back of the tube sheet.

Reset the stop collar to roll the remaining section of each tube at the front of the tube sheet. Make allowance in setting the stop collar so that the rolls overlap the previously-rolled section to avoid a sharp line of demarcation and insure no unrolled gap is left. Several such steps may be needed before the entire tube sheet thickness is rolled.

On double tube sheet jobs, the inner sheet is rolled first. Caution is required to insure no rolling between sheets, otherwise eventual pulling of tubes is a problem.

Special clutch-type expanders are available that quickly release the rolls when reverse action takes place. Thus, the slight rolling action that normally occurs in a reverse action is prevented and belling or prossering between tube sheets limited.

An alternative to step rolling is a progressive or restrictive method for accomplishing similar results. This method is generally used on sheets thicker than 4-in. and utilizes a spinning expander that moves continuously forward or backward depending on its design. It accomplishes rolling of the desired length in a single pass.

Retractive method starts with the rolls at the back of the tube sheet and has the advantage of permitting extrusion of the tube metal forward thus avoiding compression of the tube between the tube sheets.

Some practice progressive rolling on the first sheet and retractive rolling on the last sheet.

Tubes have been rolled in sheets up to 12-in. thick by this method and the speed of performance is phenomenally fast.

Watch For Length Variations

Due to tube length variations and assembling tolerances, tube end projections at the last sheet hole may vary. If objectionable or if specifications call for certain limits, these are evened off by facing or trimming.

Tools are available with stop collars permitting consistent results. Job is done by using the facers in a portable air or electric drill.

Most heat exchangers are assembled with straight tube projections. On occasion, however, the inlet end may be flared or bell mounted, particularly condensers. An appropriately shaped tool forms this by a small impact means after rolling.

Part I on mechanical cleaning appeared December 14

When you purchase process equipment . . .

What the Vendor Expects of You

A vendor answers more questions:★

- **What does the vendor need to ask you?**
- **How much pre-purchase engineering do you expect?**
- **Why is the vendor concerned about price comparison?**
- **What preliminaries strain the ethical relations?**

And buyers comment.

NORMAN H. PARKER, Tower Iron Works Inc., Providence, R. I.

We have suggested (*CE*, Dec. 14, page 161) that the subject of the ethics of dealing with vendors was one to which some thought should be devoted. In exploring this subject, we hope to develop ways in which buyer-vendor relations can be conducted in the best interest of both parties.

First, we should review briefly the question of responsibility, which we suggested is the most important decision to be made before any formal action is taken on equipment specification and purchase.

Basically, the decision should be made as to whether you (your company) are ready to accept responsibility for operation of the equipment you are about to buy, or whether you would rather turn over the responsibility for the "package" to a qualified equipment vendor. There is, of course, a middle ground in which some companies fall because of their basic internal engineering policy. On the basis of this decision on responsibility the type of vendor can be selected, either specialty fabricator or major equipment manufacturer.

★Part 2 in a series of 3

See page 84 for capsule contents of the whole series.

Again, I want to emphasize that any company jealous of its reputation for integrity and fair dealing would stand firm on its decision.

This responsibility basis should be clearly set forth in any specifications sent out for either a budget estimate or firm quotation. On whichever basis you go ahead, the definition of responsibility should be positively stated, especially if it is to be divided between yourself and the vendor.

This will have three advantages. First, there can be no question of responsibility later if the equipment fails to perform properly. Second, it permits the vendor to concentrate his effort on coming up with the best piece of equipment for the lowest first cost, without hedging against responsibilities over which he may have no control. This will be true for both the major manufacturer and the specialty fabricator. And third, as you set up your inquiry specification in this manner you may find that the first decision as to responsibility was wrong, and you can change it before you have purchased a piece of equipment which is inadequate for the job it is to perform.

Furthermore, the inquiry should be clearly labeled as to whether it's for budget purposes or a request for a firm quotation. For some process equipment, a budget estimate can be completed in one or two man-days, whereas a firm quotation would require at least two man-weeks for complete engineering and detailed estimating.

A situation which occasionally occurs and causes great consternation and concern to equipment vendors is this: After sending out for estimates from equipment vendors, and finding that the price of the job exceeds the appropriation, an engineer or purchasing agent—with the intention of acting in the best interests of his company—combines all vendors' specifications and issues a new inquiry to specialty fabricators "o get a better price." Most oft, this occurs after extended negotiations with the equipment vendors to achieve maximum capacity for minimum first cost.

CONSULTANT says .
"The selection process is best done by engineers. It matters little whether such engineers receive salaries or fees, but they should report to the purchaser. To attempt to do this work by committee or entrust it to purchasing agents, or attempt to do it by compiling the efforts of salesmen or their engineers is to

invite excess costs. The problems are those common to all "committee" jobs. The results are usually compromises based on personal or subjective or other doubtful criteria."

Another similar, equally difficult situation arises occasionally when a member of a company's engineering staff who is familiar with a particular type of equipment discusses with equipment vendors a process problem with the object of achieving optimum results. After several of the major equipment vendors have offered equipment modifications to fit the particular problem in these discussions, and the bid request goes out, there is usually consternation at the discovery of the unintentional incorporation of the special equipment modifications and design features discussed.

Both problems can be eliminated by a strong determination to make the initial responsibility decision and then staying with the firm decision.

One fact mentioned in the previous article which bears repeating is this: Major equipment vendors are essentially consulting engineers in their field of specialization. But instead of charging a consulting fee, they recover their engineering costs and earn their income on the manufacture of the equipment. Just as both consulting engineers and the major vendors are always ready to place their experience and know-how at the disposal of their customers and prospective customers, so also neither want to see their offerings prostituted and used to their disadvantage.

CONSULTANT says . . .
"It is inevitable that engineering done as an accessory to a sales function will be sales-oriented, or its practitioner will vanish from the business scene. Prudence and a native caution would seem to make a purchaser want engineering advice from an engineer reporting and responsible to him. No ethical professional engineer will accept an assignment involving the recommendation of equipment in which he has a private interest without disclosing that interest to his client. Few professional engineers can afford proprietary interests in equipment where interests may conflict with the clients' interests."

Recently, *Chemical Week* published a report of a round table discussion held by the Chemical Equipment Sales Engineers Assn. of Chicago on this general subject: "How much engineering information is the customer entitled to before order placement?" The concensus was that too much pre-order engineering was supplied, which could and sometimes had resulted in the customer's being able to draw up an order for a specialty fabricator from the detailed specifications. Comments were solicited by the editors of the magazine from equipment purchasers. One or two of the replies suggested that this was a "fact of life," one which had to be accepted by the vendors.

Basically, I feel that there is a misunderstanding on the part of some purchasers of the objections to furnishing pre-order engineering. As will be discussed in more length later the vendors are extremely interested in presenting and discussing their proposals in detail with prospective purchasers. However, they do not feel that calculations or detailed drawings should be required. The reason is that they represent the know-how and experience of the consulting engineer and actual out-of-pocket dollars literally thrown into the hands of competitors if the information is disclosed to others by the prospective purchaser.

However, the institution of a procedure based on the "responsibility decision" by equipment purchasers would clearly inform the vendors of the purchaser's intent, as well as leave no doubt as to the degree of vendor responsibility desired.

CHEMICAL COMPANY says
"We have the feeling that Mr. Parker is quite concerned over the ethics of obtaining detailed design work in proposals from vendors, and then using this information to get a cheap job done by some other firm which lacks an engineering staff. As we see it, talking about this problem is not going to change the way business is done. Suppliers will generally know by instinct the practices of the clients who solicit their quotations, and they will have to take their own chances as to how much effort they put into supplying information that may be misused for a lead to new business now or in the future."

There is no doubt that the practice of presenting some drawings in advance of an order is of long standing. Also there is no doubt that there is a definite advantage to the purchaser to have equipment drawings to complete plant layouts. However, even on custom equipment, a line drawing with over-all dimensions should provide the information required for supports, bases and other general layout information. Any special design information should be the subject of discussion between vendor and prospective purchaser during evaluation.

What else does an equipment vendor expect from you, the prospective purchaser? Three additional points are of importance to him and equally to you. These points are not necessarily in order of importance.

First, every equipment vendor is concerned that you don't attempt to make any preliminary evaluation on a "price-per-pound" basis, or on price alone. In some cases, such as API tankage, which is designed and bid to rigid specifications based on material contained and tank size, it is the custom to evaluate on the price-per-pound basis, since all

Meet Your Author

Norman H. Parker is manager of the industrial division of Tower Iron Works. He joined the company while preparing this series for *CE*, having come to it from his previous job as manager of engineering for Turbo Mixer division of General American Transportation Corp. A graduate of Brooklyn Poly's chemical engineering department, Parker is a licensed professional engineer in N. Y., R. I. and Illinois and a member of AIChE and NSPE. He is co-founder of Chemical Equip. Sales Eng'rs'. Assn. of Chicago.

prospective vendors would be quoting exactly the same weight of material, based on the API specification. However, this is not true of process equipment. As certainly as the price of peaches varies with size, quality and weight, so does the price of process equipment. And in a price-per-pound evaluation, the effect of quality—reflecting experience and know-how—is overlooked; equipment sizing—the result of functional engineering—affects the weight.

The price-per-pound evaluation also fails to determine if all vendors are quoting on the same basis. This can be especially devastating to vendors whose estimates include all equipment auxiliary to their piece of equipment, when compared to vendors quoting "all auxiliaries by customer," if no attempt is made to put the quotations on a comparable basis. Another factor that price evaluation tends to overlook is the mechanical features or basis of the designs submitted, apart from the process or functional features. Then too, price evaluation fails to consider differences in functional design.

Although all of these factors are important to the equipment vendor, they are much more important to the purchaser himself. Therefore it is difficult to understand use of price evaluation at all. Even in this period of emphasis on costs, the purchaser is deluding himself when he depends upon price evaluation alone.

Actually, vendors are concerned with price evaluation not only because it affects them, but more importantly, because of the detrimental result it may have for the purchaser. Vendors are always interested in discussing their proposals in detail for this reason. Not only do they have the opportunity of presenting the basis on which their designs were based—functionally as well as mechanically—and the special design features included, but in so doing, they assure themselves that the prospective purchaser will take these into consideration and make his evaluation on a common basis for all who have submitted quotations.

OIL COMPANY says . . .

"To facilitate equipment selection, our company utilizes a preselection procedure. Shortly after the specifications are issued, the selected vendors are called in for individual meetings with our equipment engineers. The equipment designs are studied, and the vendors are instructed as to the specific equipment they may quote. In this way, we are assured that the equipment being quoted by the various vendors is comparable and in compliance with our specifications."

These discussions permit the buyer to explore not only the range of process experience, know-how and the basis on which the equipment was designed, but also to evaluate his confidence in the vendor. Discrepancies between offerings will become evident during these discussions, and vendors can be asked to make their quotations consistant, in the sense that was mentioned above; either include or exclude auxiliaries, installation or start-up supervision. This every vendor is most happy to do, because being on a common basis, he feels that any special design feature he may have will be all the more evident.

At this point, the third factor enters the picture. The prospective purchaser now has had presented to him several functional designs, as well as the special design features which each prospective vendor has developed to provide optimum performance. The vendor has, in effect, placed in trust with the prospective purchaser his most valuable asset—the summation for that particular process problem of all his experience, research and development and engineering skill.

The vendor has a right to expect the prospective purchaser to guard this as if it were his own, and not trade design data with other vendors. Of course, every vendor wants to learn where he stands on any particular project he has quoted, but this does not release the prospective buyer from his obligation not to communicate design data.

In summary, we may say that

1. Vendors want the opportunity to discuss their proposals in as much detail as the prospective purchaser may desire.
2. They expect the prospective purchaser not to communicate design features and data.
3. Vendors try to discourage the use of "price-per-pound" evaluation because of its inherent faults which ultimately act to the detriment of the purchaser.
4. Because of past experience where design information and data provided in confidence have been broadcast or used to their disadvantage, vendors feel that pre-order detailed engineering required for evaluation should be reduced to a minimum.
5. It is the opinion of the author that the adoption and use of the "responsibility decision" would be a great step forward toward the establishment of a single ethical relationship between vendor and purchaser which would promote the best interests of both.

In the next installment, we'll discuss how all these pre-buying factors culminate in decision.

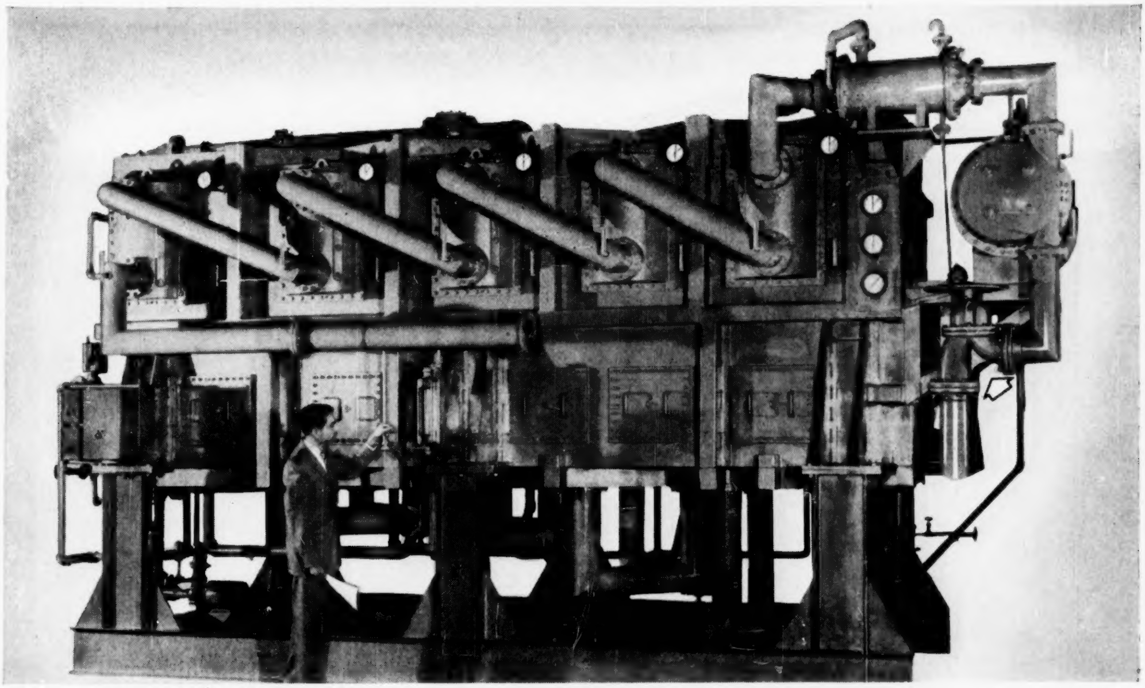
Practical Buyer—Seller Ethics

In this three-part series of articles, Mr. Parker is considering the following points:

1. **How to determine responsibility. What you should know about equipment. How the vendor should be brought into the job. (CE, Dec. 14, p. 61.)**
2. **What the vendor expects of you in a wholesome ethical relation. (This installment.)**
3. **Evaluating bid proposals. Weighing tangibles and intangibles. Making the final decision. (Coming next.)**

Let us hear from you

As a buyer (or seller) of equipment, your experience may corroborate or contradict the opinions of Mr. Parker or our commentators. What can you add to the discussion that will clarify some of the hazy areas such as responsibility, ethics and other nebulous considerations? Send your opinions—confirm, argue or amplify, as you will—to the Editor, Chemical Engineering, New York 36, N. Y.



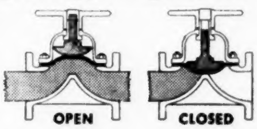
ON LAND At Salinas, a tourist center in Ecuador, this Cleaver-Brooks Flash Evaporator delivers 50,000 gallons of pure, distilled water every 24 hours. It is equipped with two 6", rubber lined, weir-type Grinnell-Saunders Diaphragm Valves — only one of which can be seen from this view.

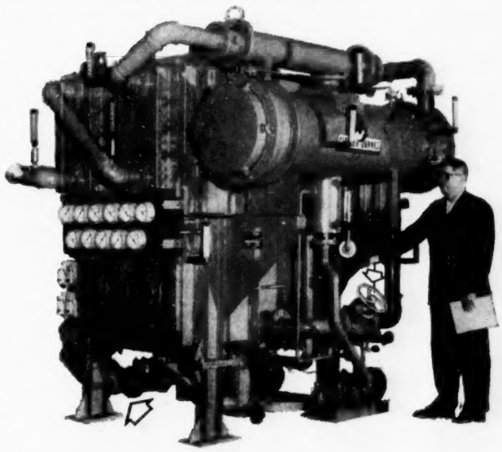
Grinnell-Saunders Diaphragm Valves help convert salt water to fresh water

You can convert sea water to fresh water, in abundant supply, on land . . . or on shipboard, with flash evaporators made by Cleaver-Brooks Special Products, Inc., Waukesha, Wisconsin. Grinnell-Saunders Diaphragm Valves are used as original equipment on these distillation units because they offer positive, leak-tight closure; flow control in throttling position; corrosion-resistance.

You'll find Grinnell-Saunders valves widely used in other fields, too . . . petroleum, papermaking, chemical, food, compressed air . . . to mention a few.

The operating principle of the Grinnell valve is the feature which makes it so adaptable. The diaphragm lifts high for streamline flow in either direction; seals tight for positive closure against grit, scale, solid matter, pressure or vacuum. Bonnet mechanism is completely isolated at all times from the fluid in the line by the diaphragm, preventing corrosion and contamination. Smooth passage, without pockets, eliminates trapping of solids and reduces frictional resistance. And you can get body, lining and diaphragm materials to meet your particular service conditions. Get *all* the facts. Write Grinnell Company, Providence 1, R. I.





AT SEA The nuclear powered NS Savannah has two 16,000 gallons-per-day Cleaver-Brooks distillation units to supply the entire water requirements of crew and machinery. Each unit has two 4" Grinnell-Saunders Straightway Valves of ductile iron.

GRINNELL

Pipe, Fittings, Valves, Hangers, Heating and Piping Supplies
Branch Warehouses and Distributors From Coast To Coast

CE COST FILE

No. 21: Labor Factors; Pipe Insulation. Cost File Index

William G Clark, Dow Chemical Co., Pittsburg, Calif.

Compute Labor Needs for Pipe Insulation

This Cost File concludes a series based on information from a handbook for training engineers in maintenance cost estimating. Use of labor factors makes it possible to apply local wage rates to these tasks. Mr. Clark is an officer of AACE.

Estimate pipe insulation on a lineal foot basis, allowing for fittings and valves. In insulation take-off, measure lineal feet straight through all fittings and valves. Then add 1 lin.ft./tee, 2 lin.ft./elbow, 4 lin. ft./insulated valve. Following table shows labor productivity for three insulations (lin. ft./man-hr.).

Pipe Size	Fiberglas	85% Magnesia	Styrofoam
½–1½ in.	10	9	5
2–4	7	6	3
6–10	6	3.7	2

These production rates are based on limited congestion; 10 ft. or less to ground or floor; weather-protected insulation; single-layer application. For conditions that deviate from these assumptions, following additions should be made to the factors:

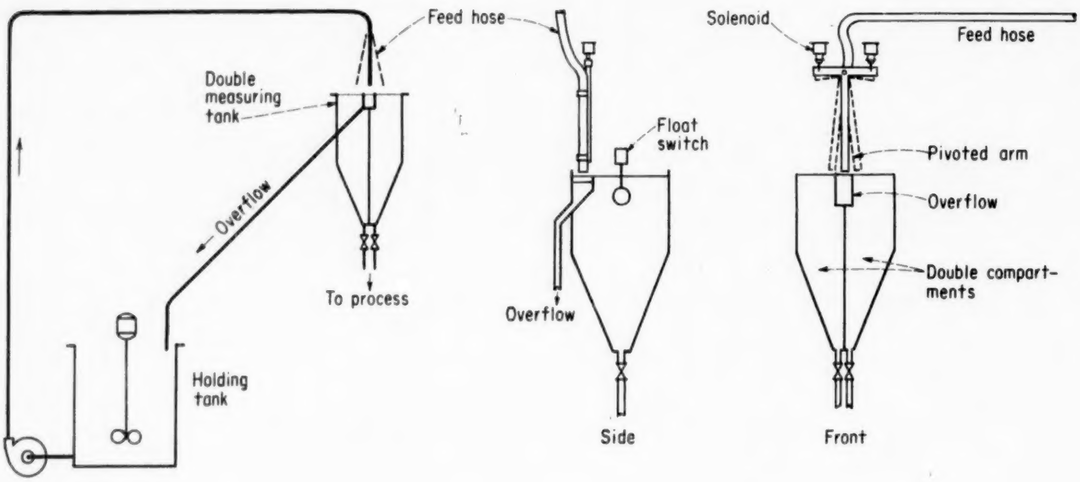
1. Add 3-5% for each additional inch over standard thickness.
2. Add 40% for double layer.
3. Add 5-10% for each additional 10 ft. of working height.
4. Add 5-10% for cramped working conditions.
5. Add 50% for aluminum or sheet metal protection.
6. If waterproof covering is not required, subtract 30% from basic factor.

Cost File Index

Send Us Your Cost Data

The nine engineers listed above have performed a valuable service and earned page rates, too. They see important economic significance in getting up-to-date data into the engineering literature.

We hope *you* see this economic significance. Use of this data for order-of-magnitude estimates helps eliminate choice of unproductive facilities—a choice that blights the entire economy. Send your correlated cost data to Cost File Editor, c/o *Chemical Engineering.*



Continuous Flow Prevents Slurry Settling

Batch measuring system for a quick-settling slurry uses swinging feed pipe discharging either to measuring tanks or to recirculation.

G. F. Livingston

Engineer, Tennessee Copper Co., Copperhill, Tenn.

We had the problem of measuring batches of a slurry which had to be kept flowing continuously in order to prevent settling of the solids. Our solution, which proved to be very successful, is diagrammed above.

The system consists of a double-compartment batch-measuring tank with the hookup arranged for semi-automatic control.

The sketch at the left above shows the measuring tank connected through a circulating pump and overflow line to an agitated holding tank. The sketches at the right show front and side views of the measuring tank and its connections.

Slurry is pumped from the holding tank through a rubber hose at a rate slightly greater than the operation requires. By pushing a button the operator energizes one of the two solenoids connected to the pivoted arm, thus moving the slurry outlet into position to fill one of the compartments. At a preset level a float switch automatically de-energizes the solenoid and allows the pivoted arm to return by gravity to its vertical position, where the slurry overflows to the holding tank.

The operation is repeated with the other compartment while the first measured batch is being used in the process. To avoid confusion, pilot lights show which solenoid is energized.

Automatic Control for Displacement Air

A. L. Haught

Staff Engineer, Diamond Alkali Co. Cleveland, Ohio.

When air is used to blow viscous material from a melting pot or other container, it is desirable to have some method to shut off the air automatically when the container is empty.

We have such an operation which requires the removal of a molten material from a melting pot by pressurizing the pot with air at 60 psig. pressure. Originally we did this by having the operator open a manual air valve and leave it open until he could

hear air escaping when the emptying operation was completed.

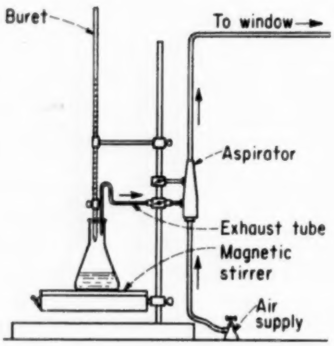
This was satisfactory until changes were made in the process, with relocation of the discharge point so that it became difficult to tell when the pot was empty. Consequently, much air was often wasted to the atmosphere.

As soon as the material discharges and air starts to blow through, there is an immediate drop in pressure in the pot to just above atmospheric. We believed this could be used to control the air shutoff. What would be needed would be a reverse-acting pressure regulator, with simplicity and low cost the factors governing the selection.

We found the equipment we needed in a Mason-Nielan lock-up valve—a device normally used for locking control valves when the supply air fails. These valves have about the same capacity as ¼-in. pipe.

The hookup consists in installing the valve in the 60-psig. air line to the pot. A manual bypass around the valve is opened initially to pressurize the vessel quickly.

When pressure has built up, the lock-up valve opens and the manual valve is closed, leaving the rest of the operation to proceed automatically. When the pot empties, pressure drops and the lock-up valve—set to respond at 18-20 psig.—immediately shuts off the air.



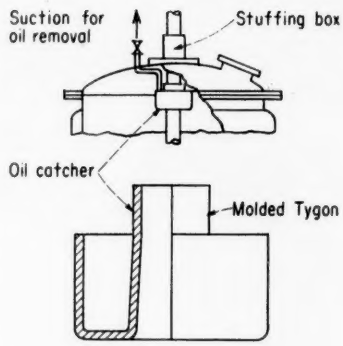
Simple Ventilator for Plant Control Tests

F. K. Ullmann
Chemical Engineer
Consolidated Refineries Ltd.
Qiryat Bialik, Israel.

The setup illustrated above is a very handy one for control tests performed in the plant, away from laboratory facilities such as hoods. We've used it in titrating "spent soda" in refinery production control where large amounts of evil-smelling mercaptans and H_2S are evolved.

The novel feature here consists in using an ordinary water-operated laboratory aspirator, but driving it with low-pressure compressed air. If desired, the arrangement can be modified to use a funnel as a hood instead of the exhaust tube shown. If you want to condense water ahead of the aspirator, install a flask between the funnel and the pump.

Another useful trick that can be handled with this setup is to fill a pipette in cases where mouth suction is impractical. Insert a glass bead into a piece of rubber tubing, connecting this end to the pipette and the other end to the exhaust tube. By pinching the rubber tube between thumb and finger above the glass bead, liquid can be sucked into the pipette and raised to the mark with very close control.



Oil Catcher for Agitator Shaft

K. Honda
Technical Engineer
Lederle (Japan) Ltd.
Tokyo Plant, Tokyo, Japan.

In vessels with a vertical agitator shaft we generally apply an oil catcher on the shaft to prevent oil and dirt from the stuffing box from getting into the vessel contents. However, with glass-lined vessels, we never had a satisfactory method of doing this, short of using a specially designed agitator shaft with a built-in oil catcher, which is rather expensive and requires a special manufacturing technique.

The molded Tygon oil catcher shown in the sketch solves the problem. Its inner diameter should be about 80-85% of the shaft diameter to insure tight fit; it can be installed by softening by heating to 90-100 C.

Next Issue: Sure-Fire Bin Discharge Method

By Max Bass, Winner of the November Contest

★ How Readers Can Win

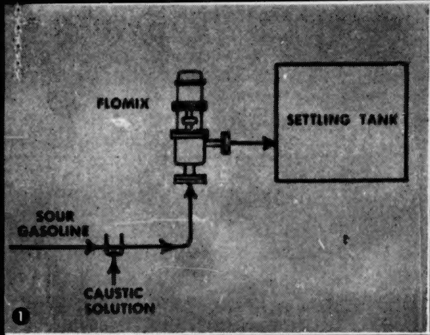
$50 Prize for a Good Idea—Until further notice the Editors of *Chemical Engineering* will award $50 each four weeks to the author of the best short article received during that period and accepted for Plant or Process Design Notebooks.

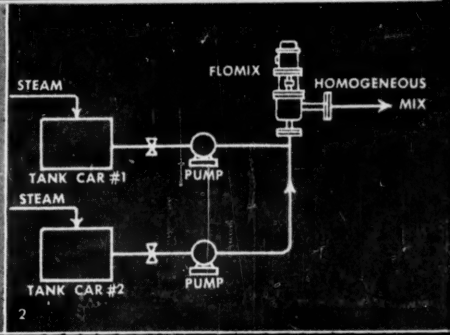
Each period's winner will be announced in the second following issue and published in the third or fourth following issue.

$100 Annual Prize—At the end of each year the period winners will be rejudged and the year's best awarded an additional $100 prize.

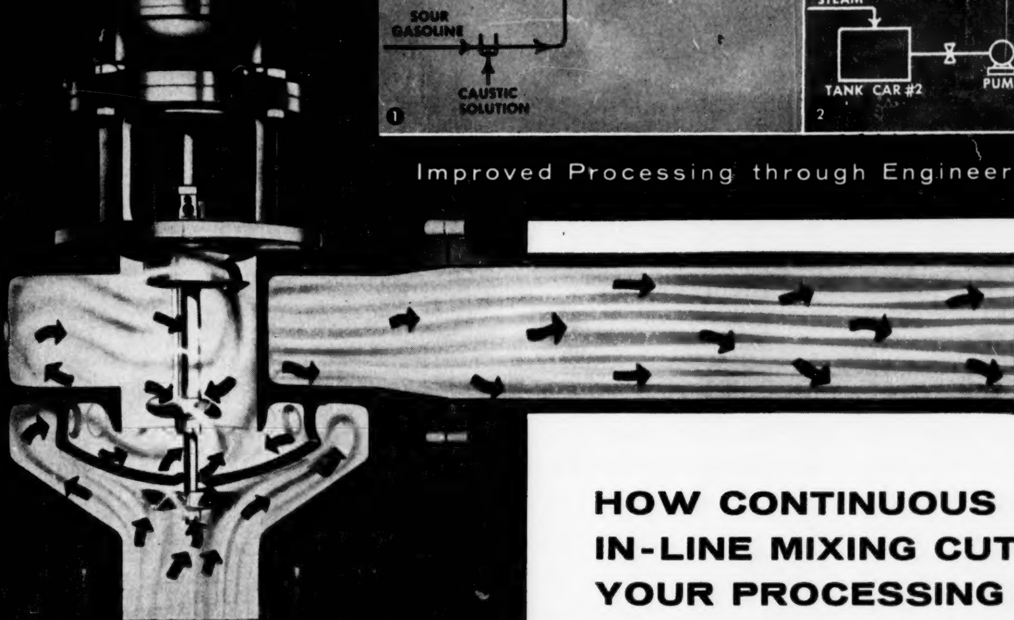
How to Enter Contest—Any reader (except a McGraw-Hill employee) may submit as many contest entries as he wishes. Acceptable material must be previously unpublished and should be short, preferably not over 500 words, but illustrated if possible. Acceptable nonwinning articles will be published at space rates ($10 minimum).

Articles should interest chemical engineers in development, design or production. They may deal with useful methods, data, calculations. Address Plant & Process Design Notebooks, *Chemical Engineering*, 330 W. 42 St., New York 36, N. Y.





Improved Processing through Engineered Agitation



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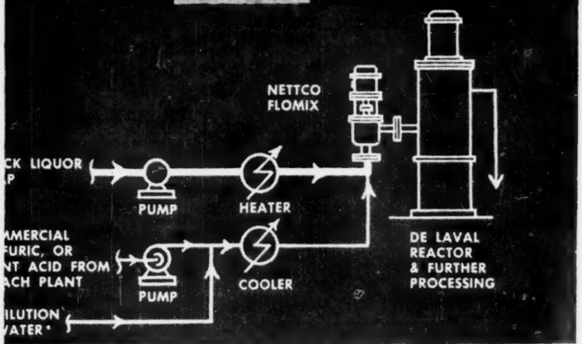

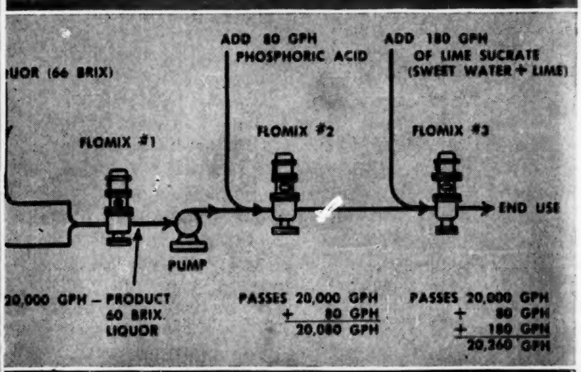

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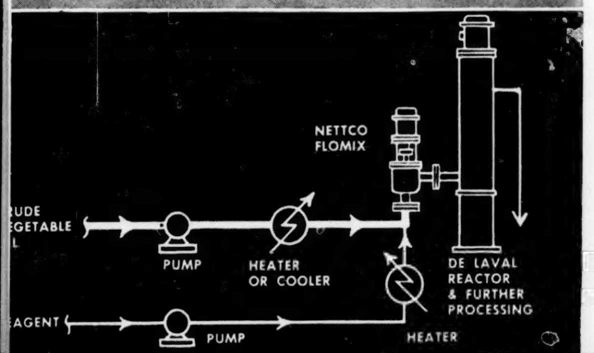

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A. L. Solliday is a geologist with almost three decades of experience in the ranks of top manage. .ent. Here's what he has to say about your future role as a manager.

A Key Phrase for the Challenging 1960's . . .

The Engineering of Managers

A. L. SOLLIDAY, President, Pan American Petroleum Corp., Tulsa, Okla.

Recently, an official of the National Iranian Oil Co. visited the U. S. for the first time since he graduated from the Colorado School of Mines in 1939.

"Twenty-three years ago," he said, "I traveled for 20 days by train and ship to get from Teheran to New York. This time, by air, the same trip took exactly one day. I suppose that by 1965, when the Mach 3 airliners are in service, I shall be able to leave Teheran at 8 a.m., right after breakfast, and arrive in New York about 4 a.m. the same morning—much too early for lunch."

His experience neatly summarizes the impact of technology on our affairs. In the last 100 years we have witnessed an amazing, truly explosive advance in human progress.

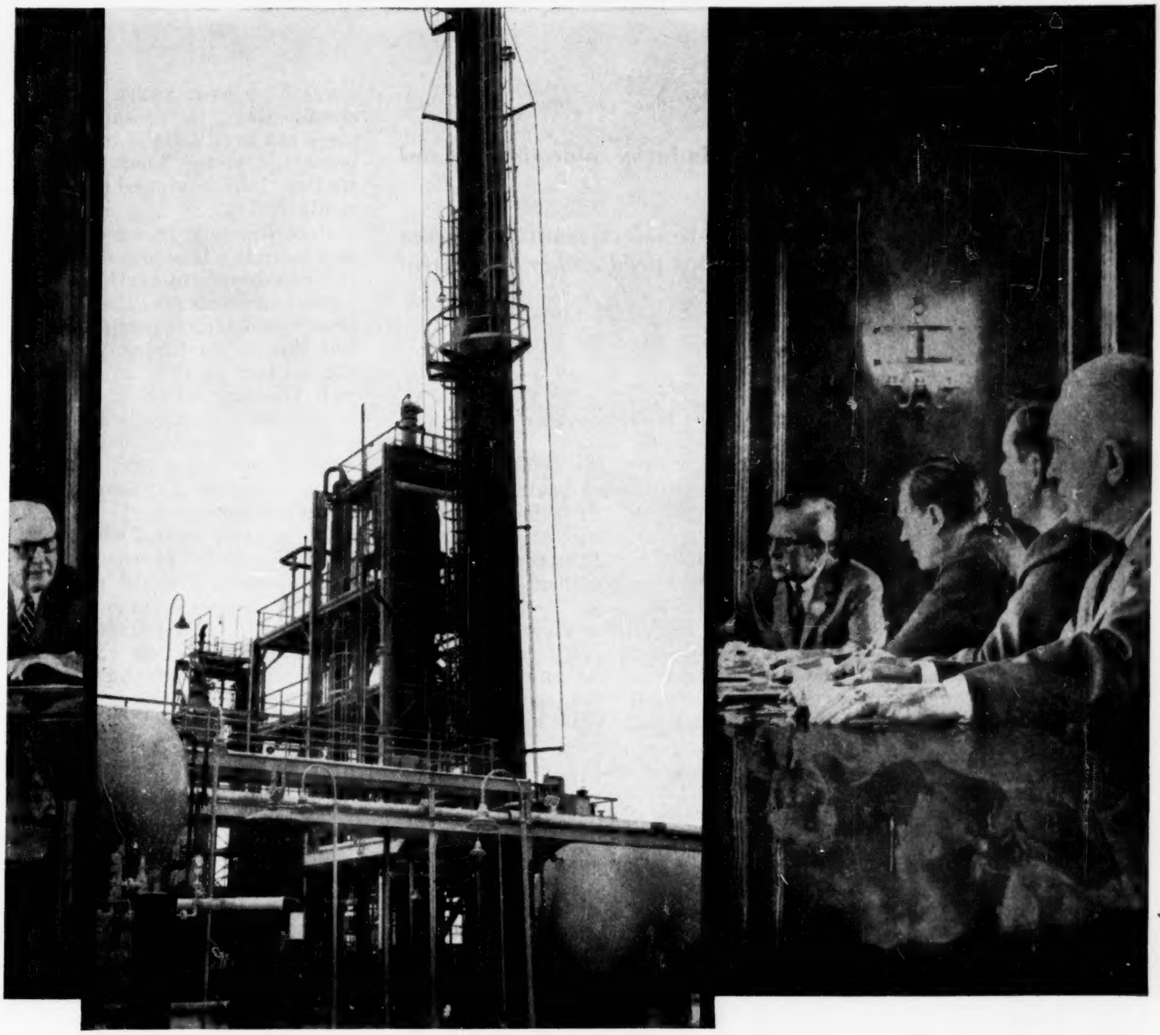
In fact, considering the entirety of mankind's recorded history — some 5,000 years — 90% of our entire technological accomplishments have occurred in the last 2% of the time span.

No less than any other social institution, the changing nature of the management function reflects the accelerating pace of technological discoveries. Automatic controls, electronic computers, growing budgets for research and development, the increasing pressures of obsolescence, the intensifying competitive scene—all of these are revolutionizing the traditional concepts of industrial management.

Under this pressure of change, management — while still an art—has acquired many of the trappings of a profession, with its own particular skills and methods, its analytical approach, its code of ethics.

Beyond that, management has tended to become increasingly a

Based on an address delivered at the 34th Annual Meeting, Society of Petroleum Engineers of AIME, Dallas, Oct. 1959. Special permission has been granted to publish this article in *Chemical Engineering* concurrently with its publication in the December issue of the *Journal of Petroleum Technology*.



We must try to find why some succeed and some fail.

We must be able to select, train and refine technical men into predictably successful managers.

science as well, requiring greater understanding in depth of technology and engineering.

▶ **Engineers Wanted**—Since this is the case, it's only logical that business today looks increasingly to the engineer and the scientist for its managerial talent.

Their particular background of education and experience provides them with definite advantages over management candidates from other fields, provided of course that they can develop the nontechnical skills and know-how that are necessary.

It therefore behooves the engineer to take a long careful look at himself and at his qualifications. Assuming that he wants to become a member of the management team, he must prepare himself for the successful performance of the broader responsibilities that will follow.

On observing his associates in the business world, he will conclude at once that many have demonstrated outstanding capabilities as top-flight administrators and executives.

He will also become aware that many others—too many in view of the increasing demands for top talent—have failed.

▶ **Success or Failure?**—This question of success or failure becomes immediately a serious challenge to both management and engineers. We must try to find why some succeed and some fail.

We must develop a body of information that will permit us to select, train and refine technical men into predictably successful managers. We must be able to *know* that the engineer promoted to a management position will make the grade.

In short, we must become expert in the engineering of managers.

In part, the solution to this problem must begin at the college level. It is there that the engineer's basic skills, his work habits, his abilities and his philosophies get their primary direction.

The engineering colleges, by and large, do a good job of preparing the engineer in the technical fundamentals. For example, if I had to step out and compete with today's engineering graduates equipped with the education I got in the 20's, I am sure I would find it hard to keep up.

Our continuing thirst for knowledge has made available a vast amount of new information which today's student must assimilate. The result is that when he graduates, today's engineer—even as a neophyte—has a much broader grasp of engineering theory and principle than did the average veteran of several years' professional experience back in the mid-1920's.

During the thirties and forties the very magnitude of increased engineering knowledge forced the schools to offer a far more concentrated training package. The engineering curriculum tended to become more confining, and more exclusive of the courses in humanities which help equip a man for responsibilities outside the purely technical occupations.

This has had the tendency of narrowing the engineer's outlook, his point-of-view and it has made all the more difficult the transition from an engineering job to a management position.

▶ **The Trend Reverses**—Educators, as well as practicing engineers have been aware of this shortcoming. In recent years there has been a trend to incorporating more liberal arts studies into engineering curricula.

Unfortunately, in some quarters there is a tendency to offset these additions to curricula by curtailing some of the basic science and engineering courses. But this is not the answer, as these basic courses are essential. The alternative—if we are to have better-trained engineers—is that engineering curricula must require more credit-hours for graduation than are sometimes recommended.

Of course, even with expanded college curricula, we cannot expect that the product of the new-look engineering school will be a finished professional manager as well as a competent engineer. Additional training and experience will be required.

As I see it, the conversion of an engineer into a manager involves two programs which complement each other. One includes the planning and study which the individual must undertake on his own initiative. The other involves the methods and techniques by which management helps the engineer.

▶ **What Is a Manager?**—At this point, it would be well to look briefly at the so-called managerial or administrative function, to see just what it is.

Several years ago, R. L. Katz of Dartmouth surveyed the administrative function under a grant from the Alfred P. Sloan Foundation. He concluded that administrative performance depends on fundamental skills rather than on personality traits. Skill, of course, implies ability which is not necessarily inborn but which can be developed.

A good executive can be better measured by what he *does* than by what he *is*.

Katz suggests that effective administration rests on three basic skills, which can be developed:

- Technical skill. Understanding of or proficiency in a particular field.
- Human skill. Ability to work effectively as a group mem-

We must be able to know that the engineer promoted to a management position will make the grade.

In short, we must become expert in the engineering of managers.

ber and to build cooperative effort within the group.

• Conceptual skill. The ability to see the enterprise as a whole. To appreciate the relationship of the company to the industry, to the community and to the social, political and economic structure of the nation as a whole.

As a man progresses up the management ranks, his changing responsibilities call for varying emphasis in the exercise of these three basic skills.

Technical skill is demanded most at the lower levels of administration, since it is effective for efficient operations. Conceptual skill, on the other hand, is most dominantly exhibited in the top executive levels, because of the need for policy formulation and the integration of varied groups and activities into a coordinated whole.

Human skill, however — the ability to understand, communicate with and motivate other persons—is required to a high degree in all levels of management.

▶ **How Much Change?**—If these are the attributes of the successful manager, how much change does the engineer have to effect in himself to become a manager, and how does he go about doing it?

Essentially, the difference between the engineer and the manager is one of approach.

The engineer is concerned primarily with the objective evaluation of facts. He is trained to apply objective standards to work performance, to strive for and insist on the highest possible degree of perfection, to assume all responsibility for his own work and to avoid the expedient solution.

A manager is basically concerned with accomplishing an objective. He must continually weigh means against ends, quality with quantity of work and maintain flexibility in operations for which he is responsible. He must learn to accept expedient solutions if they will help achieve the over-all objectives.

Above all, the manager must be able to work with and through people.

▶ **The Problem Areas**—It is no wonder, then, that the engineer frequently has trouble in adjusting to administrative duties and acquiring the "managerial mind." Here are some of the problems.

An engineer who is placed in a management job may refuse to let go of the technical details of the work—in short, "letting go of engineering." This is most often the case with the really able men. They tend to remain so involved with details of the work that broader goals are slighted.

Little time is left for developing subordinates and little responsibility is left to others. For almost all supervisors, it's difficult to let men of less experience and ability make decisions and handle jobs by themselves. This the juniors must do in order to grow.

But for engineers, it seems especially difficult to accept the delegation of authority and responsibility that is essential to modern management.

Another stumbling block for the engineer-turned-manager is the necessity for making rapid decisions and taking calculated risks. By training and experience the engineer is accustomed to collecting all the pertinent facts, analyzing them in detail and developing a considered, thoughtful conclusion.

His point-of-view is essentially conservative, and he tends to discount each factor entering into the consideration for safety's sake.

On the other hand, a manager must be able to make decisions on the basis of the best facts he has, even though all of the possible facts may not be immediately available to him. He must be able to view problems realistically rather than theoretically, and he must be able to recognize when the ultra-conservative view is appropriate and when it is not.

He needs the ability to apply imagination as well as facts to his consideration of a problem, and he must make his decisions in terms of the greatest over-all good that will result.

Also, the engineer tends to underestimate the importance of intangibles, particularly in dealing with people. His "human skills" have been neglected in his training. Consequently, he often has little patience with abstractions such as attitudes, emotions, traditions and prejudices.

The engineer cannot become a successful manager until he understands that human nature follows no scientific law, nor even—as between individuals—any broad principles.

However, it can not be fairly said that all engineers have all of these characteristics in like degree. Nor is it true that these attributes are confined solely to engineers.

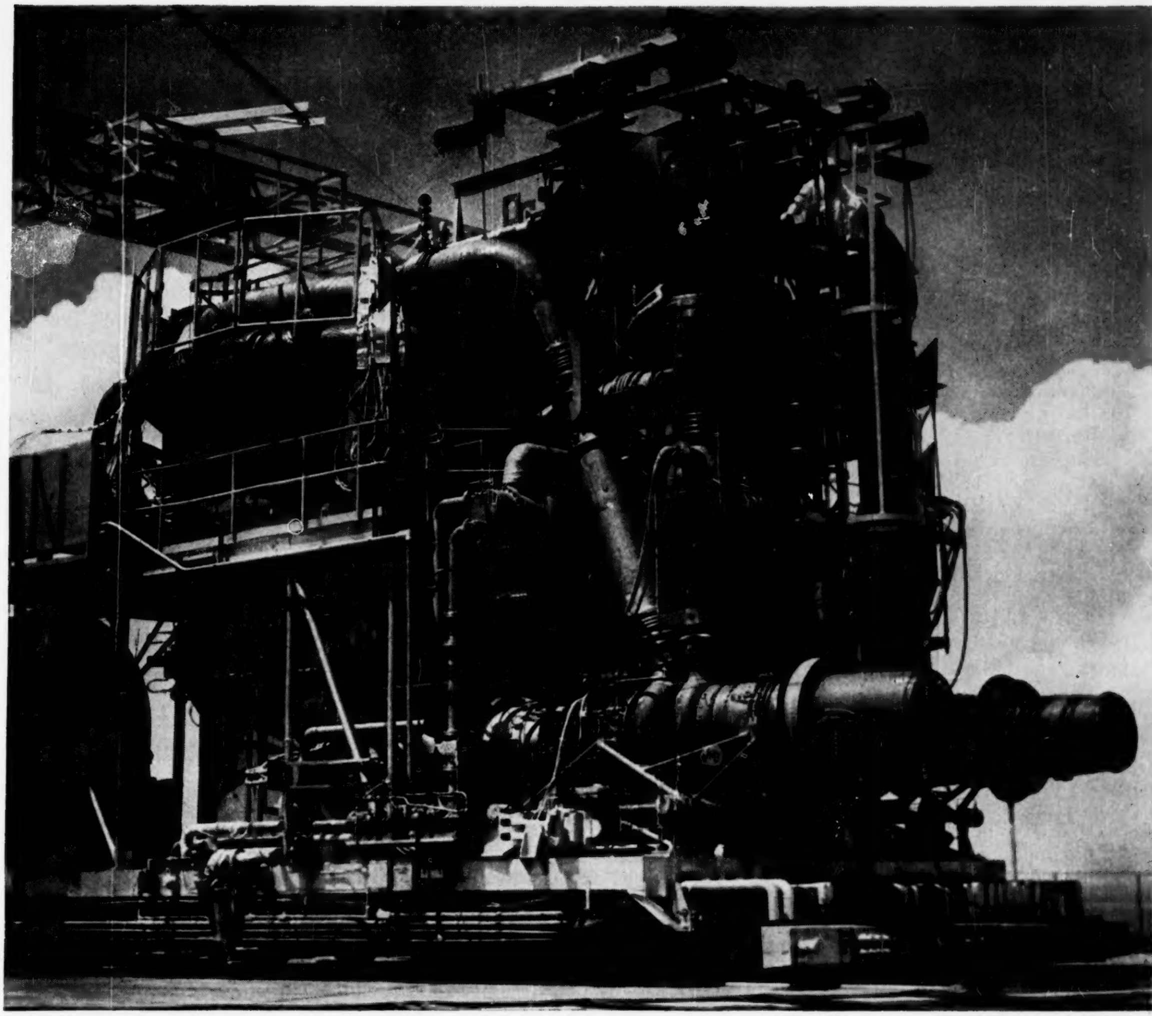
The same problems of adjustment confront virtually any specialist who moves into a position outside his immediate field of specialization.

▶ **Basically Good Material**—Let me say here that I think engineers are basically excellent management material.

If I seem to stress certain shortcomings or be unduly critical of a technical background, I do so only to emphasize the ways in which engineers can better prepare themselves for careers in management.

Let's turn our attention, then, to the problem of moulding a successful engineer into a successful manager.

As I noted earlier, both the engineer and his superiors have



a responsibility in this program. But the basic initiative must be the individual's. You can expose an individual to training, development courses and the like, but if he isn't interested in broadening himself, you can't force him to absorb either the letter or the spirit of the teaching. Nor can you make him into a successful manager.

Thus the individual engineer must first make up his own mind that he wants to become a manager, that he is willing to accept the broader responsibilities and the personal sacrifices that go with the job.

Once this basic decision is made, the engineer has a variety of avenues by which to approach his goal. Reading and study are two of the most important. They should be ingrained habits, for the successful manager must throughout his career be a constant student of the functions and responsibilities of business enterprise, and of the environment in which it operates.

He should welcome contacts with people outside his own department, in order to acquaint himself with the operations and problems of other departments, and thus gain a more comprehensive picture of the company's over-all structure and function. Going further, he should seek acquaintance with those in other companies and other industries, as a means of learning where his own company fits into the industry and into the general economy.

The engineer-manager must develop a fundamental business philosophy, an identification with the aims and objectives of his company. The successful manager derives great satisfaction from his firm's growth and development. He takes pleasure from his own contributions to its progress. At the same time, he tempers his personal ambitions by a sincere desire to promote the best interests of the organization as a whole.

Finally, and most important, he must develop skill in the art of understanding and interpreting people. As a manager, he will no longer perform work projects directly. Instead, he will be expected to supply direction and motivation to subordinates, and through them to accomplish those company objectives which lie within his area of responsibility.

To do so successfully, he must cultivate ability to know his associates as individuals, to understand them in contexts beyond the immediate business environment. Perhaps one of the soundest pieces of advice I can give—either to the engineer or to the manager—is to participate in nonbusiness, social and recreational activities with both your subordinates and your superiors. There is no better way to get to know a man than to hunt or fish with him, or play a round of golf, or see him with his family and friends, and in mixed groups.

► **Help From Above**—These are the things that the individual can do to get his career as a manager under way. They are basic and they are essential. Without these prerequisites, no man can hope to go very far in his organization.

Yet his superiors have responsibilities too. He must be given every help and every opportunity to grow and develop.

There are many things that an enlightened management can do in this direction. It will first of all make certain that its engineers have the opportunity to do *bona fide* engineering work rather than mere drafting or other routine assignments that could be handled as well by someone other than an engineer.

Management must also see to it that the engineer's work is ever a challenge to him. He must be encouraged to reach out for broader assignments, to accept new responsibilities as rapidly as he is able.

The progressive management will also keep its engineers informed as to the problems the company faces, including both technical and operating problems and those involving political or economic affairs that affect the firm's operations or profitability.

► **Only the Beginning**—Nor does the process of development cease when the engineer is actually promoted into an administrative position. In a very real sense, it is only the beginning.

By the time any man, engineer or not, moves into administrative responsibility, the company normally has quite a substantial investment in him. It hardly makes sense to assume that he is an accomplished professional manager, and to leave it up to him to sink or swim. The better course of wisdom is for his superiors to leave nothing to chance, but instead to work actively for his success—through any or all of the more-or-less formalized "executive development" techniques, and by the constant and judicious use of individualized coaching.

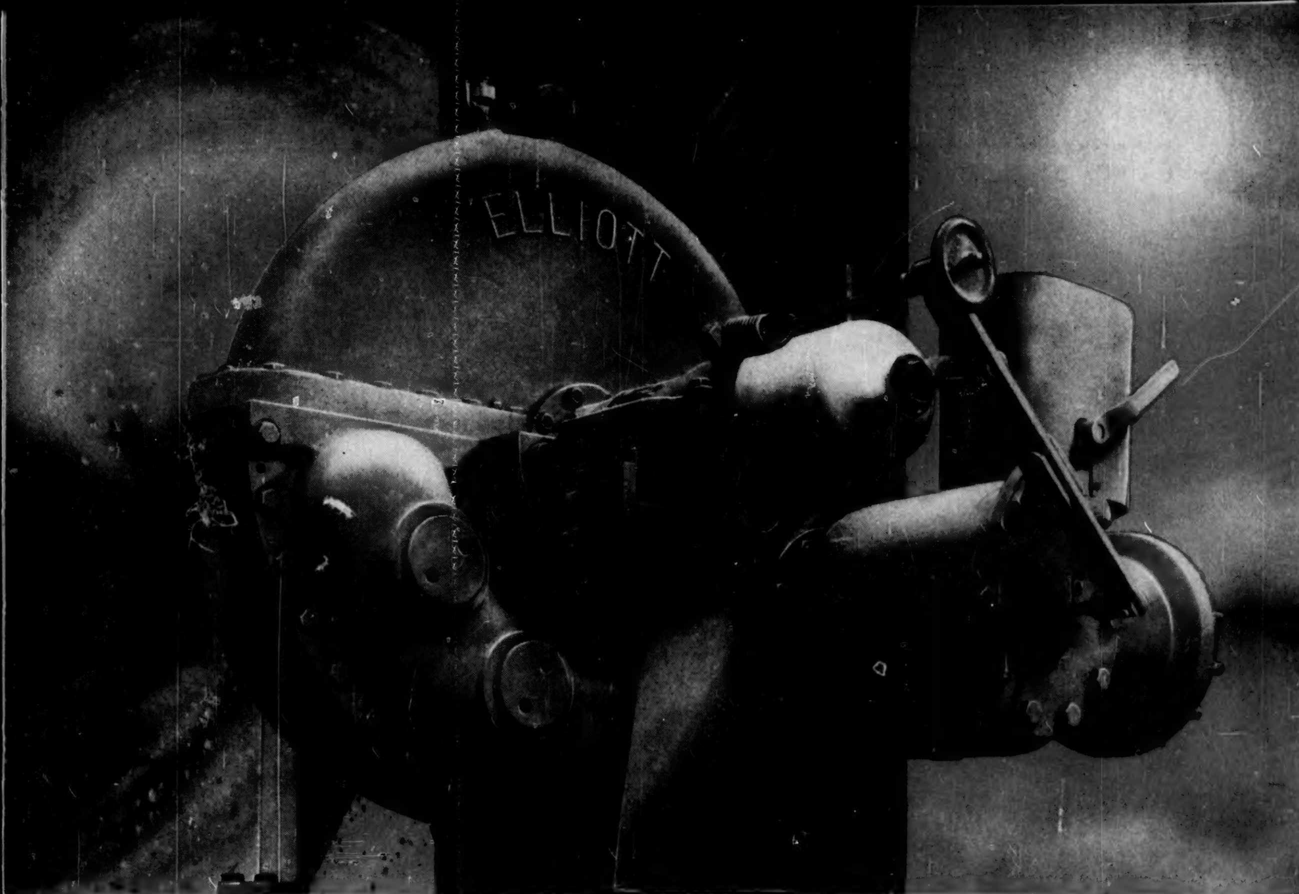
Again I must emphasize that this cannot be a one-way street. The engineer who aspires to management positions must accept the basic responsibility for his own development. Others may coach him, expose him to group conferences or executive development programs. But in the final analysis, his success or failure depends only on himself.

► **One Last Responsibility** — The would-be engineer-manager should be willing to accept one further responsibility: It is his obligation to become an effective spokesman for our economic system of private competitive enterprise.

Surveys show that Americans generally have little or no knowledge of how the system works, even though they enjoy its benefits every day. Even businessmen—involved as they are with their own affairs—often do not have a broad fundamental knowledge of economics, or the ability to discuss it.

For the engineer who is willing to accept these responsibilities for self-development, the opportunities are virtually unlimited. As business grows more complex, more technical, more interrelated and interdependent, its management and direction will require technically-oriented executives. Logically, these will come in large part from the ranks of engineers.

The engineering of managers thus becomes a very personal thing for every practicing engineer. If each one addresses himself to the solution of the problem in his own case, then the business world need not worry about its future supply of executive talent.



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The governor is simple and reliable, and is available in several modifications to match speed and pressure control requirements. YR turbines are designed for easy installation and service. Many key parts are interchangeable for various frame sizes. Four sizes are shown at the right. Write for descriptive bulletin H22-C.

In addition to the units illustrated here, Elliott makes single-stage turbines in special frames, reduction gears, multistage mechanical drive turbines to 50,000 hp, and turbine-generators through 44 m[illegible].

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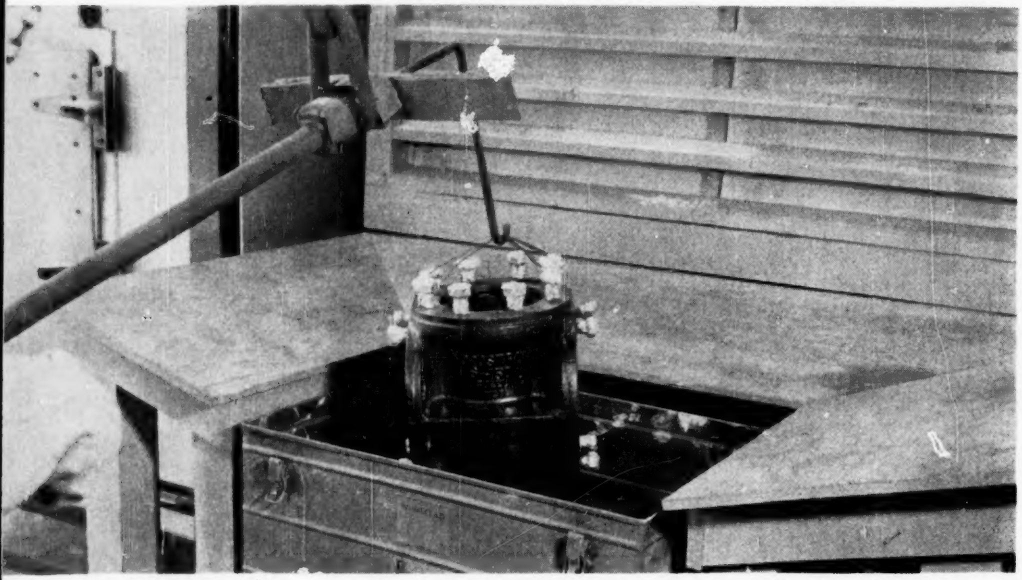


HOT DIP in bed ·nely divided plastic powder gives new life to coated-plug-valve field.

Fluid-Bed Coat: Key to Better Valves?

Fluidized sintering of chlorinated polyether plastic produces homogeneous, void-free, chemical-resistant coated valves costing 50% less than all-stainless steel.

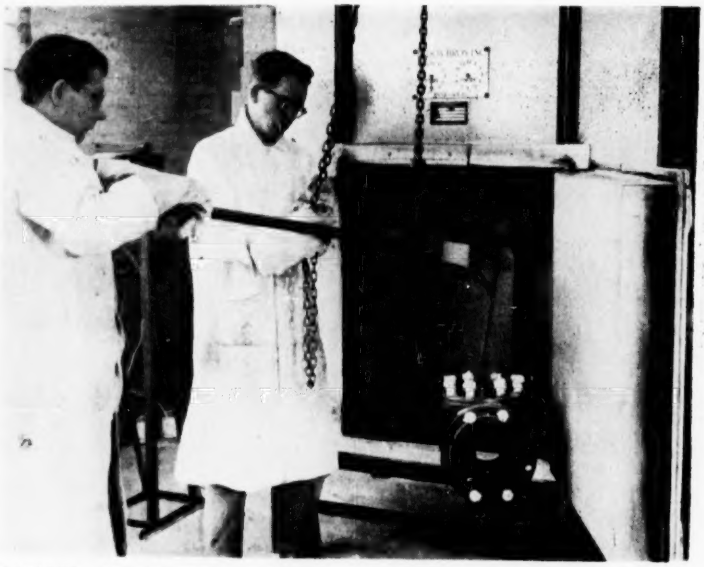
R. J. Sarraf, Rockwell Manufacturing Co., Pittsburgh, Pa.

Desirability of plastic-coated valves for corrosive service has long been recognized by industry. Basically, the attraction is a matter of dollars and cents. A plastic-coated valve can cost 50% less than an equivalent all-metal valve made of stainless steel.

Although a variety of coatings and application techniques have been tried with some degree of success over the past decade, valve manufacturers are convinced that the "ideal" plastic-coated valve is not available today. This is, of course, not news to chemical engineers. But what is news, is that a relatively new plastic material, a high-molecular-weight chlorinated polyether coated by a special, fluidized-bed technique, has come a long way in the direction of this ideal.

► **What's Ideal?**—It might be of interest to first establish what are the characteristics of a perfect coating and also evaluate some of the materials that have been and are being used. For instance:

• Easy application. The application problem is far more difficult in the case of a valve than in process equipment generally. A valve is a highly irregularly shaped object, with



BAKING, after sintering, at 450 F. insures uniform, void-free plastic coat.

sharp angles, pockets, crevices, and corners. Yet the coating must be applied homogeneously over every square inch of contact surface, or it fails. If application is cumbersome and time- and labor-consuming, any economic advantage over all-metal valves will soon be lost.

- Wide-spectrum corrosion resistance. Some coating materials have won a spot for themselves because of their excellent resistance to the corrosive effects of a particular chemical. But if a plastic-coated valve is to perform a significant service in reducing costs, it must be applicable for a variety of materials.

- Adequate service life. Obviously, low initial cost is not in itself a sufficient measure of economic usefulness. Frequent replacement can rapidly whittle away any low-initial-cost advantage. Desirable physical attributes that contribute to long life include: good surface adhesion; abrasion resistance; resilient structure; resistant to cyclic wear.

- Wide temperature range. Temperature is probably the most difficult stumbling block to overcome. Most plastic materials have low use temperatures.

Probably the first plastic valve coating material investigated in serious fashion was phenolics. This is applied simply by spraying on valve surfaces. While its chemical resistance and wear characteristics are fair, it is limited in application by brittleness.

Epoxies and modified epoxies produce relatively flexible coatings. However, they have limitations of poor wear resistance in cyclic valve operations. Method of application is also spraying as in the case of phenolics.

The polyvinylchlorides became feasible as coating materials when the Whirlclad or fluidized-bed coating process came on the market. This works very well for PVC. Chemical resistance of PVC is good, but a 140 F. temperature limitation and its less than satisfactory wear resistance narrows the area of application.

While the Teflon, Kel-F class of plastics are very attractive because of their unusual chemical inertness, extreme difficulty in coating made costs prohibitive. Because the powder has to be sintered into a homogeneous mass, high costs are involved in building up an adequate thickness giving complete protection.

▶ **Whirlclad Applied**—Shortly after the Whirlclad process was announced,* Hercules Powder introduced Penton, a chlorinated, linear, crystalline polyether of high molecular weight (see *Chem. Eng.*, Mar. 23, 1959, p. 194). Based on published physical and chemical characteristics, it seemed to hold promise as a valve coating. It's upper temperature limit is in the 200 F. range.

Since our proposed use of the material differed substantially from how it had been used before, we felt it desirable to establish the material's characteristics in our own test program.

First step in the evaluation program was compilation of corrosion data as well as mechanical properties, in the laboratory.

These tests were then followed by a field test-coupon program. Approximately 1,100 coupons were placed with chemical, petrochemical and oil refining companies in various parts of the country. Purpose was to validate our laboratory results as well as give potential users a chance to evaluate Penton-coated valves.

▶ **Valve Coating Procedure**—Much of the success of plastic coated valves, we feel, is due to the Whirlclad coating method. This technique makes it relatively simple and quick to apply a uniform, adherent and void-free coating on plug valves.

First step in the coating process involves preheating the valve part to a temperature of approximately 500 F. It is then dipped into a fluidized bed of finely divided plastic powder for about 25 seconds. This deposits a 20 to 25-thousandths thick coating which is then baked to its final state in a gas-fired oven at 450 F.

Other than routine cleaning, there is little pretreatment of the part surface prior to the coating operation. However, it is necessary to radius all sharp edges because the material coats thin on a sharp edge.

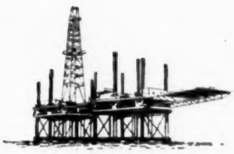
A static voltage test detects

* Developed and licensed by The Polymer Corp., Reading, Pa.

from the makers of Dimetcote...

ZINKOTE®

THE FIRST 100% INORGANIC SELF-CURING ZINC COATING.



- A radically new concept in zinc coatings for protecting steel.
- Under development for many years and first patented in 1957.
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- Can be used wherever galvanizing is satisfactory – actually gives superior protection.
- Completely nonflammable, nontoxic.
- Insoluble in all petroleum products.
- Outstanding resistance to weathering, salt and fresh water.
- Applied by brush, spray or roller.
- Cathodically protects steel.
- Resists temperatures up to 600°F.
- Complete protection for as little as 5¢ per square foot material cost.

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Although similar, each has certain unique advantages depending upon the particular requirements of the job. We will be glad to give you a specific recommendation.

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The Pioneer Manufacturer of Inorganic Zinc Coatings

119

Fluidized-Bed-Coated Valves Stand Up in Field Tests*

Lined Fluid	Conditions	Replaced
52%–58% sulfuric acid	Ambient to 212 F. below 20 psi	Lead lined
24% hydrochloric acid	Ambient 40–55 psi	Glass lined
Dry ethylene with sulfur dioxide and sulfuric acid	175 F.	Steel
98% sulfuric acid	70 F. 15 psi.	Semi-steel
Brine with 20% calcium chloride	150 F.	Semi-steel bronze
Caustic soda with edible oil	160 F. 10 psi.	Iron
Treated saturated NaCl brine to Hooker cells	130 F. 15 psi.	Cast iron; various coatings and platings
Pentane and ethane with 5% hydrogen sulfide	140 F. Atmospheric	Steel and alloy steel
45%–78% sulfuric acid	130–140 F.	Stainless steel
Isobutylene and mechanically entrained sulfuric, spent butanes	Ambient	Stainless steel
Liquid chlorine	14 F.	Teflon-coated cast iron
Copper reagent: 11%–15% copper sulfate 10%–14% sodium chloride	100 F.	Cast iron
Ethane and mechanically entrained hydrochloric	Ambient	Cast iron

* Penton-coated lubricated plug valves.

porosity in the coating. This is done in one of two ways: the valve plug is immersed slowly in an electrolytic bath; or more complex shapes such as the body is probed with an electrode. In either case a current reading will indicate a pinhole.

Spark-testing devices for coating porosity did not prove to be successful. In too many cases the instrument gave a false indication of coating quality.

► **Plastic Limitations**—As of Sept. 1959, approximately 1,000 Penton-coated valves have been in operation in chemical, petrochemical and petroleum refinery plants all over the country. They have been in use anywhere from one month to two years. The attached table is a sampling of valve installations that have been in use for at least a year of fulltime operation, without any difficulties.

Approximately 1% of the total plastic-coated valves shipped were returned because of some type of failure; the balance performed up to expectations.

In analyzing and reviewing the failures, we found that the causes were more mechanical than chemical. The chemical failures were due to incorrect application rather than unanticipated failure. The plastic has a tendency to absorb hot solvents such as trichlorethylene and benzene and swell.

A few of the early valves that went out on test failed because there were some kinks in the coating procedure which permitted pinholes to develop. Also, the inspection routine had not been finalized and the inadequately coated valves were not caught This type of failure has not occurred since.

► **Physical Damage**—The most frequent cause of failure in the 1% group was physical damage to the coating. Damage was caused by either abrasive material in the line fluid or because the valve was used for throttling—or a combination of both.

In one installation line fluid consisted of a mixture of sulfur dioxide, hydrochloric acid, chlorine and carbon tetrachloride. Piping material was carbon steel. As a result of internal pipe corrosion, the line fluid carried a fine abrasive powder. Since the valve was operated quite frequently, the abrasive powder soon eroded away enough coating and made it virtually useless.

In another example a 3-in. plastic-coated valve failed after 19 days of service. Valve was installed in a line carrying 20% sulfuric acid saturated with copper sulfate. Line pressure was 50 psi. maximum at maximum temperature of 150 F., and the valve was operated 6 to 12 times daily.

► **Don't Throttle**—An examination of the valve clearly showed its use in throttling service. The plastic coating remained partially attached in large strips—although the valve body itself had been eaten through—indicating that the coating had been loosened by corrosion of the base metal, rather than by actual attack of the plastic.

When a lubricated plug valve is throttled, area of flow for the line fluid is reduced. This increases the flow velocity at the plug port and valve body throat edges. Throttling, by interrupting the laminar flow pattern, causes cavitation. The combination of increased velocity and cavitation introduces a damaging erosion factor—one that is particularly potent in the case of a plastic as soft as Penton.

ROBERT B. SARRAF, chief chemical engineer at Rockwell Manufacturing Co., is a chemical engineering graduate of the Univ. of Pittsburgh. He worked at Mellon Institute and Garco Products before joining Rockwell. Mr. Sarraf is a member of American Society of Lubrication Engineers and AIChE.

Chemical Engineering

WALLACE F. TRAENDLY
Publisher

S. D. KIRKPATRICK
Editorial Director

CECIL H. CHILTON
Editor-in-Chief

In August 1946 *Chemical & Metallurgical Engineering* was renamed *Chemical Engineering. Chemical & Metallurgical Engineering* was the successor to *Metallurgical & Chemical Engineering*, which, in turn, was a consolidation of *Electrochemical & Metallurgical Industry* and *Iron & Steel Magazine*. The magazine was originally founded as *Electrochemical Industry*.

McGRAW-HILL PUBLISHING COMPANY, INC., NEW YORK CITY

Volume 66

January to December 1959

GENERAL ALPHABETICAL INDEX

A

B

NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

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NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

Q

R

NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

T

U

V

NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

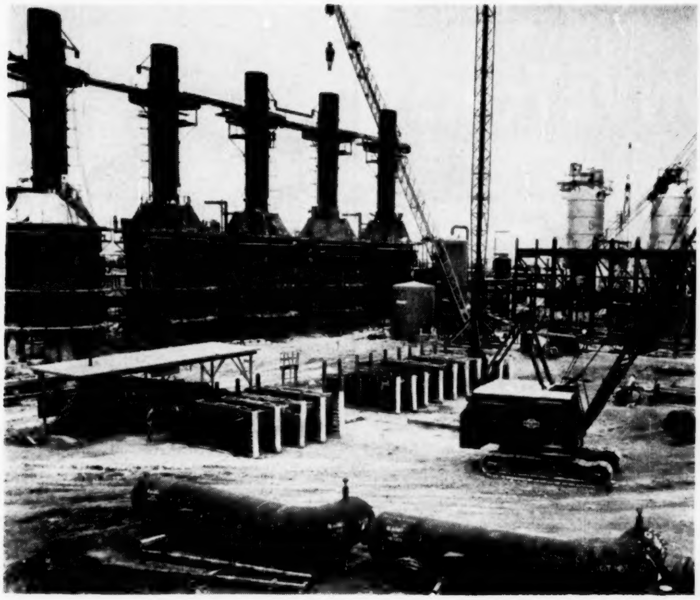
AUTHOR INDEX

NOTES—(D.N.) Design Notebook; *Illustrated; (N) News; (P.N.) Plant Notebook

FIRMS IN THE NEWS

J. A. KING

NEW FACILITIES



Kellogg Scales Up the Direct Route to Sponge Iron

M. W. Kellogg Co., New York, N. Y., is now completing construction of this upscaled 500-ton/day version of the "HyL" pilot unit at Monterrey, Mexico. Both pilot and commercial units are designed and constructed by Kellogg (Chem. Eng., Nov. 16, p. 223).

When commercial unit goes on stream, early next year, five Kellogg reforming furnaces will supply hot reducing gases for direct reduction of iron ore (see pp. 50-53.)

Aluminum Company of America announces plans for construction of Mexico's first aluminum smelting plant. Mexican bank, Intercontinental, S. A., and Alcoa have formed Alumino, S. A. to operate the 20,000-metric-ton/yr. plant, to cost nearly $20-million.

Air Reduction Sales Co. has begun construction of a 30-ton/day air-separation plant at Baton Rouge, La. New $2-million plant, to isolate liquid oxygen, nitrogen and argon, will go on stream next Spring.

American-Marietta Co. announces plans for a $30-million expansion program, including construction of seven new plants and addition of new research facilities. New kilns at Manistee, Mich., and Woodville, Ohio, will be first expansion of A-M's lime and dolomite output.

Anchorage Gas Corp. has begun engineering for construction of a natural-gas pipeline from newly discovered gas fields 165 miles to Anchorage. Pipeline, to supply 10-billion cu. ft./yr. of gas, will cost nearly $15-million.

Alaska Lumber and Pulp Co. has placed on stream its new $60-million pulping plant at Sitka, Alaska. When test runs

FIRMS . . .

are completed, plant's 120,000-ton/yr. capacity is expected to go on stream.

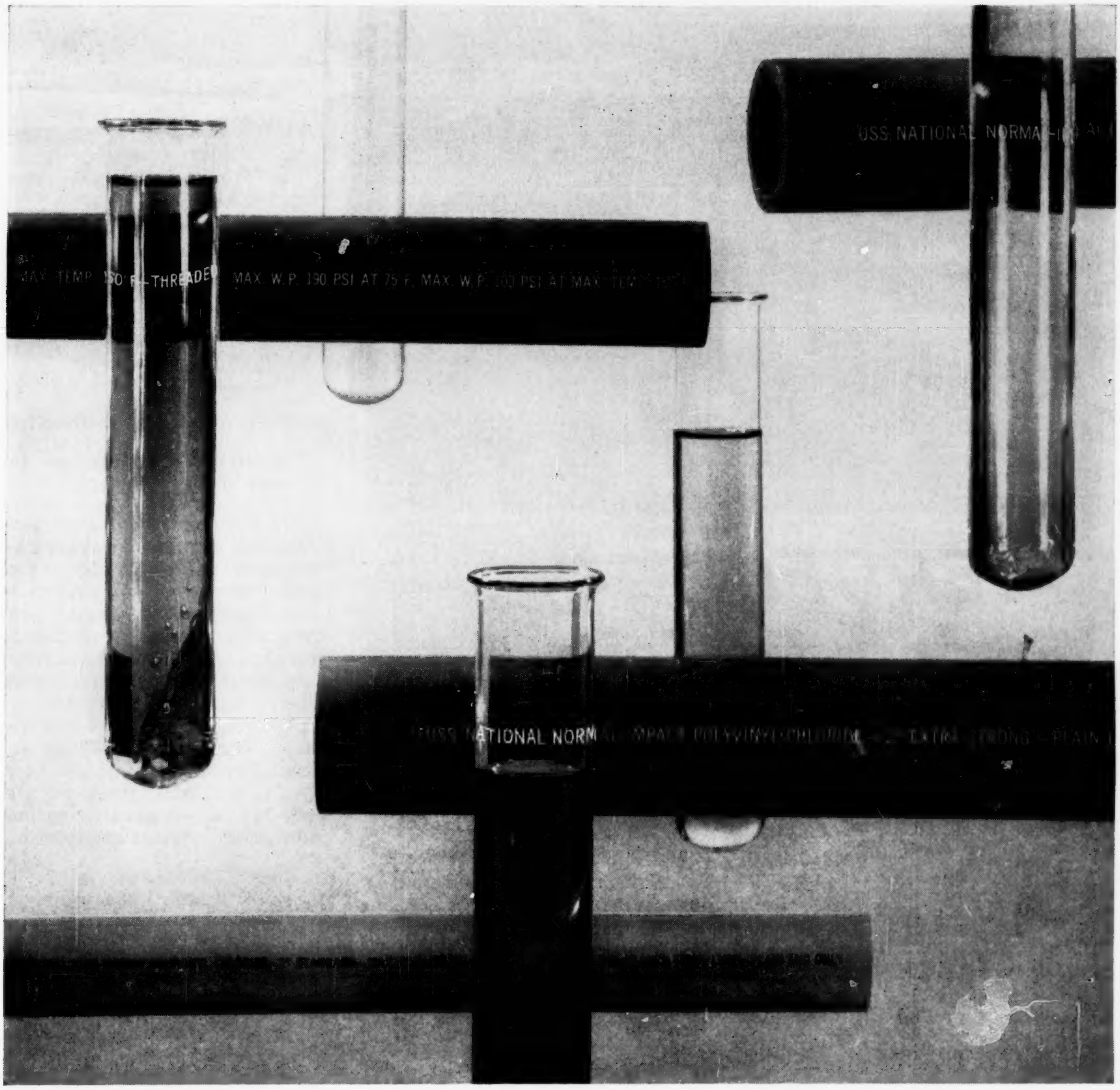
Lummus Co. has signed a $10-million AEC contract to perform architect-engineer services for a 20,000-kw. high-flux nuclear reactor at Brookhaven National Laboratories. Curtiss-Wright will design the nuclear reactor.

Esso Research and Engineering Co. has opened new facilities at Florham Park, N. J. for process research. Some 800 engineers, scientists and technicians will soon move into spacious new buildings.

C. F. Braun and Co., Alhambra, Calif., is making inroads into the nuclear industry, has signed a $5-million contract to perform architect-engineer services for design of a Nuclear Test Plant (NTP). General Nuclear Engineering Corp. of Dunedin, Fla. and Combustion Engineering, Inc. of Windsor, Conn. will aid in nuclear design. NTP will be located at the National Reactor Test Station, Idaho Falls, Idaho.

Calaveras Cement Co., a recent acquisition of the Flintkote Corp., will build a $14-million cement plant at Redding, Calif. New plant with capacity to produce 1.5-million bbl./yr. is scheduled for completion by early 1961.

Wah Chang Corp. plans consolidation of its metals testing facilities in a new laboratory at Albany, Ore. Refractory alloys, molybdenum and tungsten, are now tested for stress, rupture and hardness in five laboratories, spread all over the U.S.



Water or corrosive liquids . . . It's all the same to USS National PVC Pipe!

USS National Polyvinyl Chloride Pipe *does* handle acids, alkalies, salt solutions and alcohols as safely and efficiently as it transports water—that's one of the reasons why it's being used so widely in the chemical industry today.

There's no chemical corrosion with National PVC pipe, no building up of internal deposits. And it cleans easily, installs quickly, and has a low initial cost. Because National PVC pipe is plastic pipe, it does not contaminate sensitive solutions—*liquids remain chemically pure* inside National PVC.

USS National PVC Pipe comes in sizes from ½ inch to 14 inches in diameter, and Schedules A, 40, 80 and 120.

Two types are available:

Normal Impact—the highest chemical resistance possible, plus high strength and excellent creep resistance.

High Impact—excellent chemical resistance and a high degree of toughness, even at low temperatures.

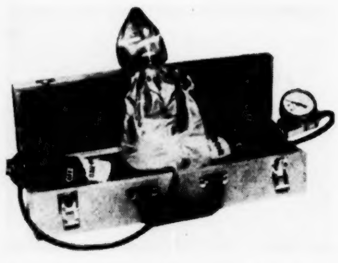
For more information on USS National PVC pipe, write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania. Ask for Bulletin No. 24. *USS and National are registered trademarks*

The world's largest and most experienced manufacturer of tubular products

National Tube Division of United States Steel

Columbia-Geneva Steel Division, San Francisco, Pacific Coast Distributors
United States Steel Export Company, New York

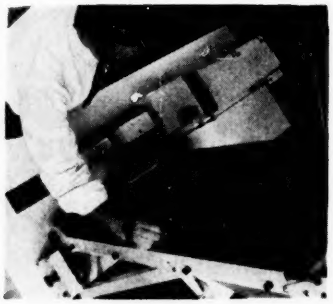
(*Continued from p. 48*)



Emergency Resuscitator

Portable unit attaches to any size supply tank.

Weighing only 2½ lb., the new Oxy-Quik emergency oxygen resuscitator kit includes face mask, rebreathing bag to prevent oxygen waste, two oxygen cylinders (one as spare), carrying case, and an automatic pressure-reducing regulator and gage. Adapters are available for refilling or use of Oxy-Quik directly from commercial cylinders. Approximate oxygen flow rate is 6 l./min.; tank supply lasts 12 min.—**General Scientific Equipment Co., Philadelphia, Pa.** 124A



Spectropolarimeter

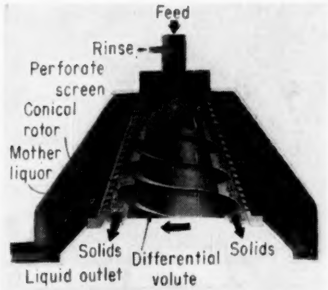
Automatic recording device in use for first time.

A new spectropolarimeter at Eli Lilly & Co. automatically records a curve of optical rotation for an optically active compound in only 20 min. On conventional instruments, such curve plotting requires 2 to 3 hr.

Developed by Rudolph Instruments Engineering Co. in conjunction with Lilly's Analytical Research Dept., the device will

detect very subtle differences of very similar compounds. In operation, a motor gradually turns the prism of a monochrometer through the full range of light waves from a xenon arc.

As polarized light passes through the sample, the angle of rotation varies with wave length. This light information, transformed into electrical information by a photoelectric cell, is automatically recorded on a graph.—**Rudolph Instruments Engineering Co., Little Falls, N. J.** 124B



Continuous Dehydrator

For high-capacity deliquefying of slurries.

Sharples Corp., has added a new item to their line of centrifugal processing equipment—the Perforate - Screen Continuous Dehydrator. Designed primarily for separation processes on feeds containing high concentrations of medium-to-coarse crystalline solids and fibrous pulps, the unit has a solids handling capacity ranging from less than 100 lb./hr. to 70 tons/hr. Residual moisture down to 1%.

In operation, slurry feeds into the top of the rotor. Solids deposit uniformly on the filter surface, and pass over a gradually increasing screen area under control of the differential volute. Since the rotating assembly is conical, centrifugal force exerted on both liquids and separated solids increases as diameter increases. Thus, solids are subjected to maximum centrifugal force just before they discharge from the bottom of the bowl. Maximum dryness is the result. Mother liquor passes through the per-

forate plate into a collecting cover and discharges by gravity.

Change in screen size and rotational speed permits accommodation of a wide variety of slurries, with varying degrees of liquor clarity and/or solids dryness.—**Sharples Corp., Philadelphia, Pa.** 125A

Chlorine Detector

Enables field measurement of chlorine in air.

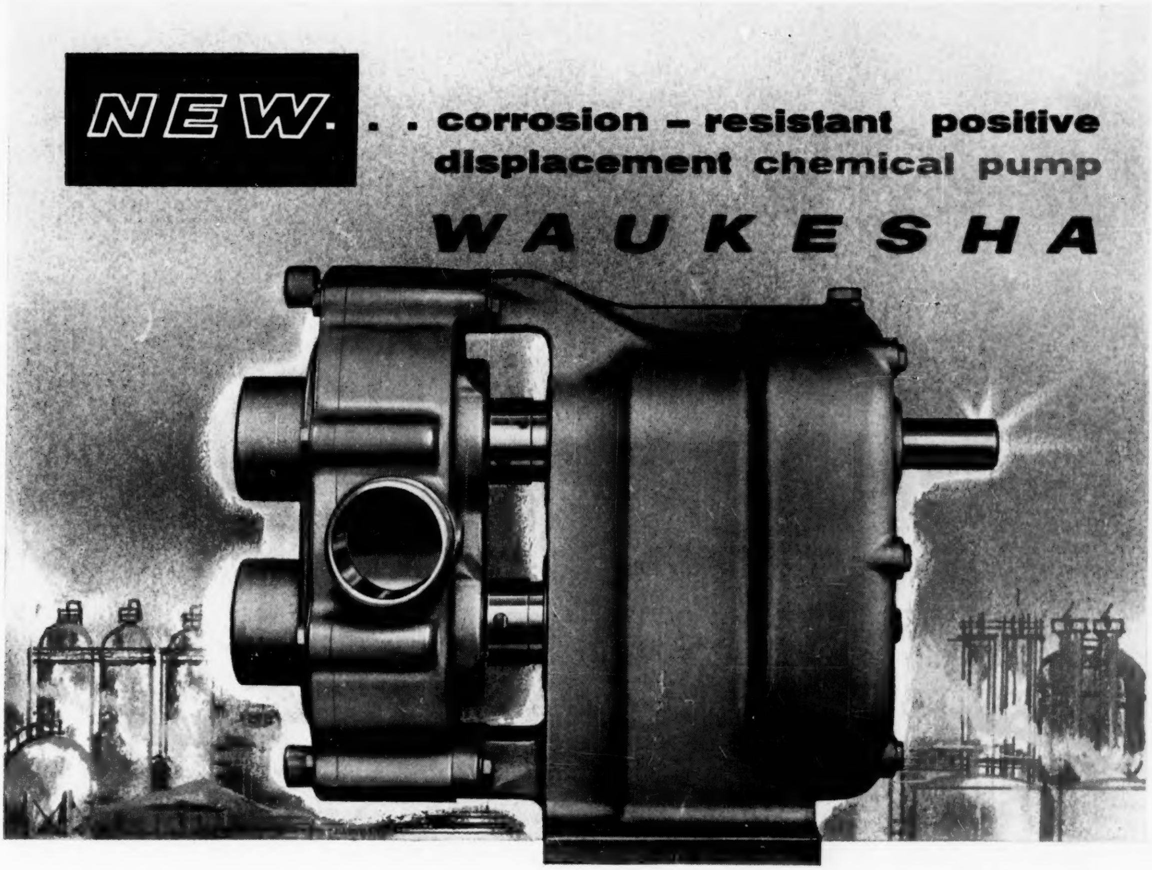
Field measurement of chlorine-in-air concentration is the function of a new detector kit manufactured by Mine Safety Appliances Co. Limits of sensitivity range from ½ to 20 ppm.

Actuation of an aspirator bulb draws samples across a "break-tip" detector tube containing an impregnated silica gel. The proportional length of blue stain created by reaction of the chlorine with the gel indicates chlorine concentration.

Housed in a compact carrying case, the detector comes complete with 12 break-tip tubes. Sampling lines for remote locations are offered in 10-, 25- and 50-ft. lengths.—**Mine Safety Appliances, Pittsburgh, Pa.** 126A

BRIEFS

Shaft seal for temperatures to 450 F. can resist pressure differentials in one or both directions as high as 30 psi. at shaft speeds to 15,000 surface ft./min. Units, which are available for shaft sizes from ½ to 8 in. dia., will fit existing lip-seal cavities without alter-



slow speed...heavy duty...longer life...

This "Waukesha" has been specifically designed for the chemical industry . . . to handle without turbulence, pulsation, aeration or agitation, corrosive-problem liquids of high or low viscosity. It has been engineered by the world's largest producers of stainless steel positive displacement pumps. This new "Waukesha" has completed more than 2 years of rugged field tests . . . promises the chemical industry years of dependable service.

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- Helical timing gears for smooth operation.
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- Quick disassembly of pumping head.
- 500 R.P.M. maximum speed — 200 lbs. P.S.I.

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Waukesha offers a competent staff of engineers to aid you in your pumping problems. Representatives in all major cities, territorial managers, and direct factory representatives.

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WAUKESHA FOUNDRY COMPANY Dept. 104, Waukesha, Wisconsin

positive displacement pumps... centrifugal pumps... stainless steel fittings... corrosion resistant castings

ation. — **Universal Grinding Corp., Cleveland, Ohio.** 126B

Stainless steel strainers for pressures to 4,000 psi. can be cleaned without removal from the line. Offered for ¼-, ⅜- and ½-in. high-pressure piping, in a choice of four mesh sizes.—**Spraying Systems Co., Bellwood, Ill.** 128A

Relief valves for liquid oxygen provide protection for insulated, stationary containers and piping. Specified pressure settings range from 75 to 450 psi. Sizes vary from ¼ to 1½-in. NPT male inlet connection. A mechanism to facilitate manual venting is optional.—**Bastian Blessing Co., Chicago, Ill.** 128B

Nylon tube inserts protect inlet ends of condenser and heat-exchanger tubing from corrosion, erosion and abrasion. Formed with an internal taper to assure uniform flow, Duro-Serts feature a design that also prevents large particles from entering the tubes. A bonding adhesive locks the insert in place.—**A. F. Gilbert Co., Jersey City, N. J.** 128C

Equipment Cost Indexes . . .

	June 1959	Sept. 1959
Industry		
Avg. of all	234.3	235.8
Process Industries		
Cement mfg.	227.9	229.9
Chemical	235.7	237.5
Clay products	221.5	223.4
Glass mfg.	222.5	224.2
Paint mfg.	226.6	228.0
Paper mfg.	227.1	228.8
Petroleum ind.	231.4	232.9
Rubber ind.	234.0	235.7
Process ind. avg.	232.8	234.1
Related Industries		
Elec. power equip.	246.7	239.4
Mining, milling	237.1	239.0
Refrigerating	264.7	266.4
Steam power	221.8	223.2

Compiled quarterly by Marshall and Stevens, Inc. of Ill., Chicago for 47 different industries. See Chem. Eng., Nov. 1947, pp. 124–6 for method of obtaining index numbers; Feb. 23, 1959, pp. 149-50 for annual averages since 1913.

TECHNICAL

An Introduction to

Nuclear Chemistry

Add another to the growing pile of nuclear-technology primers for engineers and scientists. This new volume aims specifically at the chemically oriented man, emphasizes the key role of chemistry in development of nuclear power.

Perhaps this new volume, entitled "Chemistry of Nuclear Power,"* is misnamed. It's hard to find nuclear-power generation, as such, in the book; less than a third of the volume is devoted to power reactors. But this makes the book no less interesting to chemical engineers, whose sole interest in nuclear power is in reactor materials, feed-material preparation, radioactive waste disposal, fission product separation and isotope-separation techniques.

Authors, Dawson and Long, touch on all of these areas in their review of radiochemistry. But because the scope of the book is so broad, all of these topics are but touched on, it fails to go into much practical detail.

And the authors lean almost entirely on British nuclear industry to illustrate applied nuclear chemical knowhow. For example, most of the very limited discussion on U-235 production centers around Britain's Capenhurst and Springfield atomic energy facilities.

British achievement is emphasized to the exclusion of some quite significant development in other lands. For example, there is no mention of the fluid-bed hydrofluorination and fluorination at Allied Chemical's Metropolis plant. And the statement that hydrogen distillation for deuterium isolation has not been successful, is quite false. German Linde and Sulzer Bros., Winterhur, Switzerland, have both succeeded in isolating deuterium by this method. (*Chem. Eng.*, May 18, 1959, p. 73.)

* CHEMISTRY OF NUCLEAR POWER. By Dawson and Long. Philosophical Library, New York, N. Y. $10.

BOOKSHELF

J. B. BACON

The book, however, offers quite a clear introduction to nuclear technology, particularly from the chemical engineer's standpoint; it therefore has its useful place as a primer.—JAK

BRIEFLY NOTED

BUREAU OF MINES SYNTHETIC LIQUID FUELS PROGRAM, 1944-55. Part I—Oil from Coal. *306 pp. Superintendent of Documents, Government Printing Office, Washington* 25, *D. C.* $1.50. Describes in detail Bureau of Mines Research during 1944-1955 on production of synthetic liquid fuels from coal; includes chapters on gasification, gas purification, coal hydrogenation, Fischer-Tropsch synthesis, with detailed illustrations of equipment and processes.

WRITING AND PUBLISHING YOUR TECHNICAL BOOK. 50 *pp. Dodge Books, F. W. Dodge Corp.,* 119 *W.* 40 *Street, New York* 18, *N. Y. Free.* Designed to help authors organize and develop ideas for books, answers questions about author-publisher relationship, presents checklists for preparing material for publication.

MORE NEW BOOKS

ORGANIC CHEMISTRY. By Donald J. Cram and George S. Hammond. McGraw-Hill. $8.50.

TURBULENCE—AN INTRODUCTION TO ITS MECHANISM AND THEORY. By J. O. Hinze. McGraw-Hill. $15.

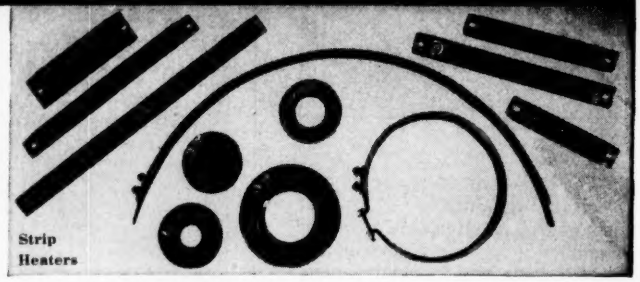
GERMAN-ENGLISH SCIENCE DICTIONARY, 3rd. ed. By Louis De Vries. McGraw-Hill. $7.

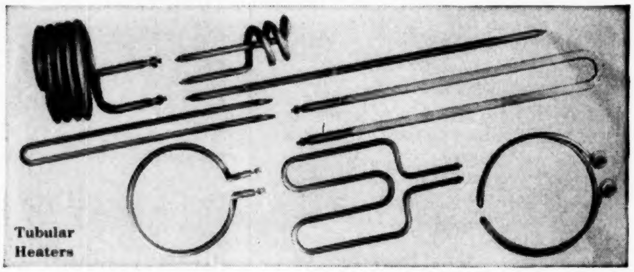
NONDESTRUCTIVE TESTING HANDBOOK. Society for Nondestructive Testing. Ronald Press Co., New York. 2 vols. $24.

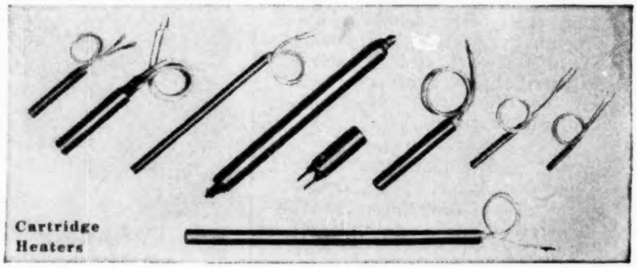
PROGRESS IN CRYOGENICS. Edited by K. Mendelssohn. Academic Press, New York. $11.

RUSSIAN-ENGLISH DICTIONARY OF NUCLEAR PHYSICS AND ENGINEERING. By N. N. Ershov. Y. V. Semenov and A. I. Cherny. Associated Technical Services, P. O. Box 271, East Orange, N. J. $9.

Call your CHROMALOX Man for the heating answers







These 3 basic CHROMALOX heaters provide answers to just about any heating problem

Strip Heaters . . . that quickly and easily bolt or clamp to platens, dies, kettles, tanks, pipes, rolls, drums, ovens and air ducts. Lengths from 4 to 96 inches, widths from $\frac{3}{4}$ to $2\frac{1}{2}$ inches, with cross section curving or lengthwise bending. Available with brazed-on fins.

Tubular Heaters . . . that clamp on, fit into machined grooves, cast into metals, immerse in liquids, install in ovens and ducts. Straight lengths or factory-formed to nearly any contour. Lengths from 6 inches to 30 feet. Triangular or round cross section. Available with brazed-on fins.

Cartridge Heaters . . . that smoothly fit standard drilled holes in dies, platens, molds, extrusion and injection barrels. Special leads available for protection against flexing action, abrasion, moisture or vapors. Diameters from $\frac{3}{8}$ to $1\frac{19}{64}$ inches, lengths from $1\frac{5}{8}$ to $25\frac{3}{8}$ inches.

Versatile Chromalox electric heaters are available in sheath materials and wattages to match almost any application to 1100°F. Easy to install, they are fast, clean, safe and economical.

Each has particular advantages. Your Chromalox Man can help you determine the one that best answers your specific problem. He's backed by the world's largest factory stock of industrial heaters, ready for immediate shipment. Why not give him a call. You'll find his phone number listed at the right.

Our new Catalog 60 provides detailed product information and suggests numerous applications for the complete line of Chromalox electric heaters for industry. If you have not yet received a copy, please let us know.

7760

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Electric Heat
INDUSTRIAL • COMMERCIAL • RESIDENTIAL
EDWIN L. WIEGAND COMPANY
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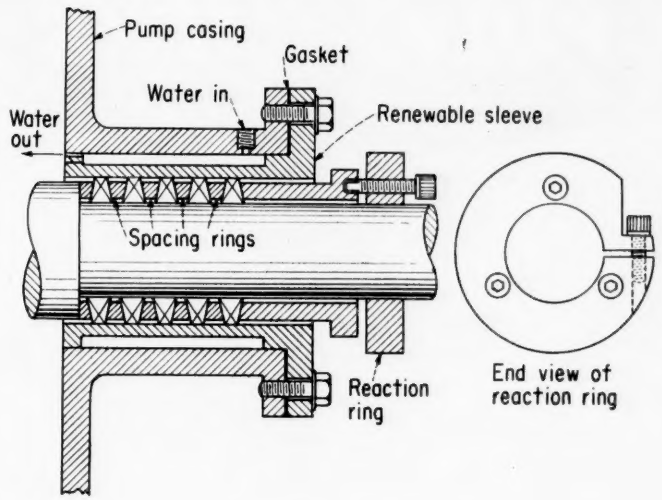
LETTERS: PRO & CON

C. H. CHILTON



Inverted Stuffing Box

Sir:

Having read Mr. Heap's article (June 1, pp. 128-132) and Mr. Coopey's letter (Aug. 24, pp. 185-186) on pump packing problems, I thought your readers would be interested in a new stuffing-box design which has been tested at the British Hydromechanics Research Association.

Leakage from a conventional stuffing box is sometimes reduced by tightening up the gland bushing. Too much tightening increases frictional torque and causes overheating, binding, burning of the packing and excessive shaft wear. These bad effects are usually avoided in practice by allowing a relatively large cooling leakage to take place, but this can hardly be called good sealing practice.

The design shown in the sketch was recently suggested by Imperial Chemical Industries. The packing rotates with the shaft, and the rubbing takes place between the packing and casing. Cooling of the rubbing surfaces becomes much easier.

Tests at our laboratory have confirmed this view and proved that the inverted arrangement permitted operation with a tighter gland bushing. Leakage rates with this stuffing box were as low as 0.02 cc./min. for extremely long periods and are comparable with those of mechanical seals. Packing life was greatly extended, and wear on the casing was low.

The inverted stuffing box is now successfully used on an autoclave stirrer.

L. E. Prosser
British Hydromechanics Research Assn.
Harlow, England

JUST BETWEEN US . . .

Dear Readers:

This month we have reached an important milestone in a 57-year publishing history.

The copy of *Chemical Engineering* now in your hands is part of our second 50,000 print order. With about 2,400 copies going to advertisers, agencies and our own internal use, the balance of 47,600 represents paid circulation.

You might be interested in

knowing a little about this group of 47,600 subscribers to which you belong:

- 73.3% of you work for manufacturing companies.
- 13.1% work for engineering firms, research labs, governmental agencies or are independent consultants.
- 9.4% are connected with educational institutions as professors, instructors or students.
- The rest of you work for distributors, financial institutions, transportation firms and a variety of other organizations allied with the chemical process industries.

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- 6.4% are research and technical directors or chief chemists.
- 5.7% are chemists or metallurgists.
- 21.7% are company officials (or hold subscriptions addressed in the name of the company).
- The remainder are in such functions as sales, purchasing or market research.

As you know, we get these data by asking you a number of questions about yourself and your company when you apply for a subscription. Your answers to these questions help us keep abreast of your interests and specific informational needs.

Trends in the composition of our audience have brought about many editorial changes. For example, our Process Design Notebook and the Operation & Maintenance department were recently started to serve growing numbers of readers in these fields.

PAUL W. ERB
Circulation Manager
Chemical Engineering

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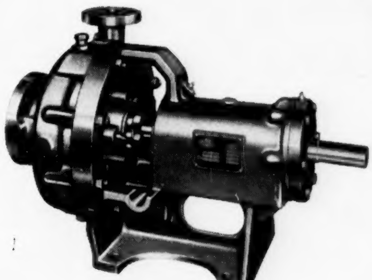

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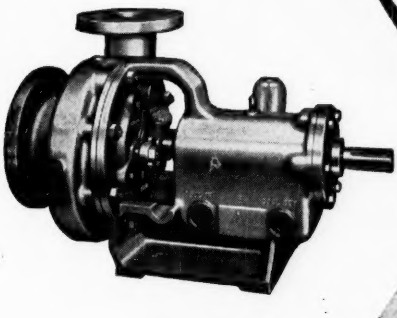

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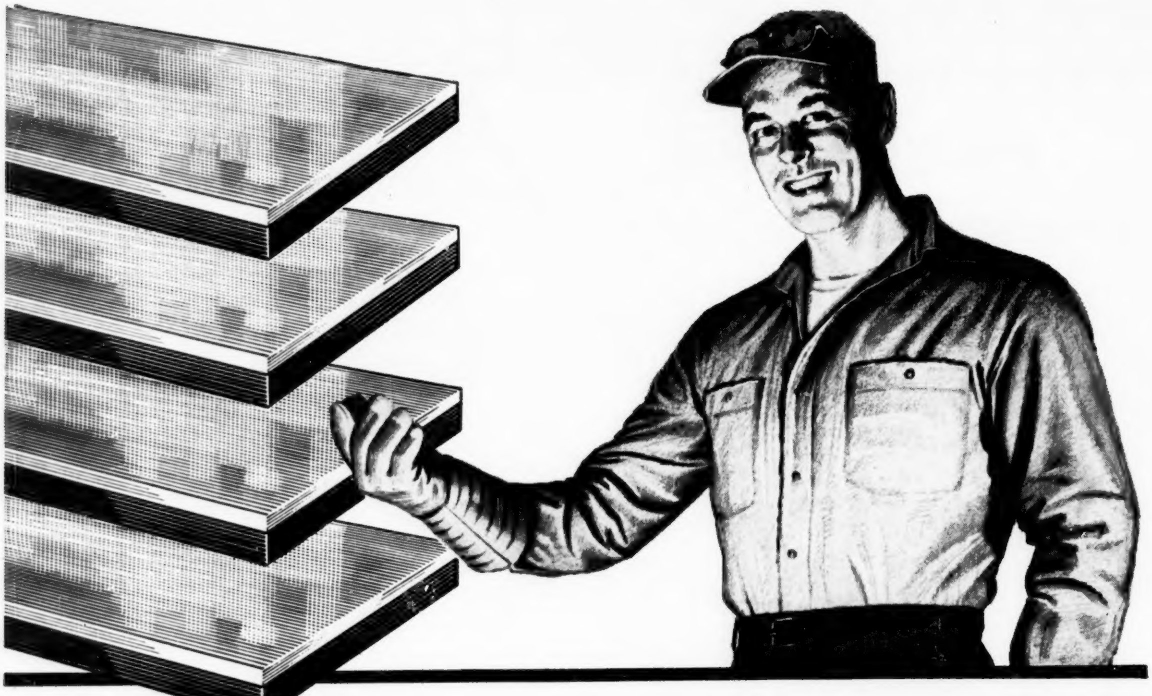

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140A Rohm & Haas Co.

Arcylic resin......Brochure on Baker PL-11, an acrylic-type polymer for injection molding & extrusion. Excels polymethyl methacrylate some ways.
140B J. T. Baker Chemical Co.

Agricultural Chemicals......40 p. booklet covers products of company's farm chemical & insecticide division. Covers applications, research facilities.
140C S. B. Penick & Co.

Boron Trifluoride......Technical data on the properties & typical uses of B&A Boron Trifluoride gas or any of its complete listed is available on request.
23 *Allied Chem., General Chem.

Chemical......Diamino Chloro Triazine (Dact) is a product that offers two types of reactive groups in a single molecule. Additional information is available.
8-9d *American Cyanamid Co.

Chemicals......Research chemicals are listed by name, structural formula, description, property data and size of sample in a 56-page booklet now available.
20-21 *The Dow Chemical Co.

Chemicals......A copy of the technical service bulletin TS-2, "Storage and Handling of Nacconate Diisocyanates is now available on request.
89 *Allied Chemical Corporation National Aniline Division

Chemicals......Excellent solvent properties plus low volatility, good wetting action & low toxicity make QO Furfural a superb stripper ingredient. Information.
37 *The Quaker Oats Co.

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E. M. FLYNN

Diphenolic Acid......5 p. bulletin 2 surveys synthetic resins based on diphenolic acid. Contains data on observed characteristics, DPA in polyamid resins, phenolic resins.
141A S. C. Johnson & Son

Epoxy Resin......Company's epoxy resin adhesive packs for repair & maintenance are described with photographs, diagrams and text. Features are listed.
141B Fenwal Inc.

Etchant, Aluminum......1 p. bulletin AE-16S, Solid Aluminum Etchant—Non-Scaling, Dustless, Easy to Handle," contains photos showing handling procedure.
141C Pennsalt Chemicals Corp.

Hexachlorophene......Supplement to Bulletin H-1, "G-11 (Hexachlorophene U.S.P.)-An Annotated Bibliography," includes abstracts of 23 articles, 4 patents.
141D Sindar Corp.

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Cover *Shell Chemical Corp.

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141E Standard Oil Co., Indiana

Methylene Chloride......Samples and copy of reprint "Methylene Chloride for Raising Solvent Flash Points and its Effect in 27 Solvents available on request.
41 *Allied Chem., Solvay Div.

Paint Strippers......4 p. brochure describes complete line of strippers including fast-evaporating, cold chlorinated, organic emulsion, hot alkaline.
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142A U. S. Industrial Chemicals

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146 *Metal & Thermit Corp.

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150 *Du Verre Inc.

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Stainless-Clad Plate......provides protection against corrosion, abrasion or product contamination. Full details are available on request.
136 *The Colorado Fuel & Iron Corp.

Stainless Steel......A complete selection of literature is available on different sizes, shapes & finishes. Publication list describes over 150 technical pieces.
162 *Allegheny Ludlum Corp.

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Cooling-Tower Drive......High-horsepower wormgear drives designed specifically for cooling tower service are covered by Bulletin 135-S. Helpful information.
143A Cleveland Worm & Gear Co.

Electrical Equipment......Condulet is the one complete line for corrosive locations. Bul. 2699 contains full information on Condulents for corrosive locations.
18 *Crouse-Hinds Co.

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143B PIC Design Corp.

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99 *Elliott Company

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143C Essex Conveyors, Inc.

Vibrating Conveyors......features an exclusive dual-shaft vibrating mechanism with splash oil lubricating system. Complete information in illustrated bulletin No. 5602.
122 *Lecco Machinery & Engr. Co.

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142b *D. J. Murray Mfg. Co.

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124 *Aerofin Corp.

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Thermo-Panel Coils......Take the place of old-fashioned pipe coils. Complete data and prices on the latest models which assure increased capacity are available.
TR152 *Dean Products, Inc.

Tubular Heaters......that clamp on, fit into machined grooves, cast into metals, immerse in liquids, install in ovens & ducts. Available with brazed-on fins. Cat. 60.
132b *Edwin L. Wiegand Co.

Unit Heaters......are available in Horizontal & Down Blow models. All cast iron built for steam pressures up to 250 PSI 450 Degrees. Catalog 956.
142a *D. J. Murray Mfg. Co.

Vapor Condenser......The "Aero" Vapor Condenser holds temperatures to close limits in entire processing column. Descriptions & capacities in Bulletin 129.
L152 *Niagara Blower Co.

Instruments & Controls

Data Processing System......Information on the 123 Data Processing System or an on-stream survey may be obtained by writing for Data File 14-53-09.
14 *Beckman Instruments Inc.

Data Processing System......The new IBM 1620 is a desk-size engineering computer. Solves problems like; reactor design, mass spectrometry, kinetics, etc.
25 Interna. Business Machine.

Flow Meter......Bellows flow meter models are available in many ranges for both flow & liquid level measurement & control. Details & reference data Catalog C22-1.
6-7 *Minneapolis-Honeywell

* From advertisement, this issue

LITERATURE . . .

Instrument......Radionic for positive on-off control & determination of liquid or solid level within a closed vessel or piping using nuclear radiation. Bul. 558.
B161a *Instruments, Inc.

Instrument........Elect-o-probes are now in use for detection of liquors & foam in pulp & paper mills; heavy fluids, acids & fluid interface. Bul. B-06.
B161b Instruments, Inc.

Leak Detector......Type 60 Mass Spectrometer Leak Detector for highly sensitive service is covered in Bulletin GEZ-2939. Principles, features and application data.
146A General Electric Co.

Level Transmitters........Pneumatic force-balance transmitters for measurement of level over range spans of 1 in. H_2O to 2,000 in. H_2O are covered in Specification P31-1.
146B Bailey Meter Co.

Liquid Level Controls......Floatless Electrod type are unaffected by acids or caustics. Unaffected by pressure or temperature. A 32-p. catalog gives specifications.
148 Charles F. Warrick Co.

Magnetic Gage......for liquid level observation for plants with dangerous explosive or inflammable conditions. Available with electric alarms. Engineering Sheet offered.
L151 *Jerguson Gage & Valve Co.

Thermocouple Wells......Catalog G-102-1 provides all information necessary to select proper well for any application. Corrosion dat, P & T ratings, pricing information.
146C Minneapolis-Honeywell

Scientific Instruments......New 112-page catalog contains specifications for over 300 products used in the physical sciences. Galvanometers to electron impact tubes.
146D The Ealing Corp.

Pipe, Fittings, Valves

Expansion Joints......made from a wide variety of stainless & high alloys for important nuclear, missile & industrial applicaitons. Details on request.
147 *Solar Aircraft Co.

Expansion Joints......Catalog 56 contains complete & comprehensive engineering data for Expansion Joints from 3" to 50" diam., pressures to 3600 psi, temp. to 1600 F.
97 *Zallea Brothers

Pipe......Saran lined pipe, fittings, valves & pumps are available for systems operating from vacuum to 300 psi, from below zero to 200 F. Information available.
87 *Saran Lined Pipe Co.

Pipe, PVC......comes in sizes from ½ inch to 14 inches in diameter, & in schedules A, 40, 80 & 120. Two types are available: Normal Impact and High Impact. Bul. No. 24.
123 U. S. Steel, Nat. Tube Div.

Pipe Wall Gage......Illustrated folder covers latest product modifications for noncontact x-ray device for metals and nonmetals. Wall thickness measured to 1% accuracy.
146E Daystrom, Inc.

* From advertisement, this issue

Valves, Ball......features a new remote control which can be operated on AC or DC current. Opens & closes valves instantly from any distance. Details in Catalog No. 57.
145 *Rockwood Sprinkler Co.

Valves, Butterfly.....Condensed bulletin describes complete line of butterfly valves. Eight designs are discussed in tabular form. Sizes range from 1 to 108 in.
148A Continental Equipment Co.

Tube Fittings......Four-page folder offers condensed information to help select proper fittings for various service and installation requirements. Shape charts.
148B Parker Fittings & Hose

Tube Fittings......Condensed catalog contains comprehensive listings of brass and steel tube fittings, working tools, hose ends and assemblies. On request.
148C Weatherhead Co.

Valves & Fittings......Standard valves and fittings for 30,000 and 60,000-psi. service are detailed in new 16-page catalog. Dimensional data, cross-sectional drawings.
148D High Pressure Equipment Co.

Valves, Fittings, Flanges, Unions...... Catalog F-10 contains complete information on types & trims to best meet severe fluid & gas handling duties at all temps. & pressures.
58 *Henry Vogt Machine Co.

Valves, Diaphragm......offer positive, leak-tight closure; flow control in throttling position; corrosion-resistance. Used in petroleum, food, chemical, & other fields. Facts.
85 *Grinnell Company

Valves, Globe & Angle......for applications requiring valves for service temp. from 0 to 160 FR., pressures to 400 psig WOG. Application & specification Catalog No. L-475.
35 *The Bastian-Blessing Co.

Process Equipment

Aeration Ejectors......New brochure contains practical information useful in planning, installing & cost-estimating new or expanded facilities.
143 *Penberthy Mfg. Co.

Agitators & Mixers......Turbine-type propeller (to 120" in tanks to 50' dia.), slow speed, high speed, air lift, vertical turbine mixers, mixer-settler units. Bul. A2-B2.
125a *Denver Equip. Co.

Attrition Scrubbers......High power input to efficienctly remove sand coatings, mix dense slurries. Rubber lined or acid-proof tanks. Sizes to 56" x 56". Bul. A-8505.
125b *Denver Equip. Co.

Ball & Rod Mills......offer operation & convertibility. Wet or dry grinding systems. Sizes to 10' x 20'. All steel construction. Bulletin B2-B20 now available.
125c *Denver Equip. Co.

Blenders, Rotary......available in nine standard models with capacities to 900 cu. ft. Feature self-cleaning, dust-sealed drum. More information on Blenders in Bul. 080B.
R151 *Sturtevant Mill Co.

* From advertisement, this issue

LITERATURE . . .

Centrifugal Separators........Details and illustrations of a series of Westfalia centrifugal separators designed for purification and dehydration of fats, oils.
148E Centrico, Inc.

Centrifugals, Split-Case......Field Engineer will be glad to work with you in selecting the best equipment for your specific requirements. Request details.
128 *Fairbanks-Morse

Continuous Dehydrator......available in four sizes, including the Model 51J with solids handling capacity of 70 tons per hour or more. Literature about advanced design.
33 *The Sharples Corp.

Cooling Towers......Bulletin KT-104 describes Kennard/Nelson cooling towers. Explains construction, specifications and performance details. Three models offered.
150A American Air Filter Co.

Dust Collectors......Duclones, in a wide variety of capacities & in multiple units & special materials to meet a variety of dry dust control applications. Bul. C-958.
4 *The Ducon Company, Inc.

Dust Control......Complete details on Pangborn's engineering knowledge and experience in dust control is now offered to you. Available on request.
131 *Pangborn Corp.

Filter......Bulletin 3306 details principles of operation, design characteristics and advantages of the American (disk-type) Saveall filter. Photographs, flowsheets.
150B Dorr-Oliver Inc.

Filter Presses......can be made with new glass reinforced Polyester plates & frames. Catalog includes details of Plate-Shifters, Closing Devices & other accessories.
141 *D. R. Sperry & Co.

Filter, Pressure......available in a wide range of sizes & models. Technical bulletin indicates ways in which this equipment may be applicable to your product or process.
16 *Rodney Hunt Machine Co.

Filters......Details on size, construction materials and special features of FEinc rotary pressure filters plus other data is now available on request.
49 *American Machine & Metals

Grinding Media......A general review of grinding media and mill considerations is included in a new 12-page publication. Discusses media size, shape and density.
150C Patterson Foundry & Machine

High-Speed Dispersers......Brochure 8-D covers the manufacturer's entire line of high-speed, multiple-action Dispersers. Complete specifications chart, and construction.
150D Charles Ross & Son Co.

Jaw Crushers......Cast steel frame, anti-friction side bearings & bumper bearings. Sizes from 2¼" x 3½" to 36" x 48". Details in Bulletin C12-B12.
125d *Denver Equip. Co.

Mixer......New Model RL Hi-Shear offers finer, faster blending, dispersing & homogenizing. Features controllable flow pattern. All parts stainless steel. Information.
126 *Gabb Special Products, Inc.

* From advertisement, this issue

LITERATURE . . .

Mixers......You'll find a wealth of information on fluid mixing in bulletins describing Lightnin Mixers. Condensed catalog shows all types. No. B-109.
164a *Mixing Equipment Co., Inc.

Packaged Pulverizers........for any small-scale continuous dry grinding or pulverizing problem and a similar unit for small-scale wet-grinding. Bul. AH-448-11.
*Hardinge Co.

Process Equipment......"Sub-A" Flotation is available in sizes from 16" x 16" to 72" x 72". Three types: "Cell-to Cell"; "Free-Flow"; Type "M". Bul. F10-B86.
125f *Denver Equip. Co.

Processing.....Flomix combines liquids, solids & liquids, or gases & liquids which in combination, will readily flow through piping. Ask for Bulletin 531A.
91 *Nettco Corporation

RDC Columns......in successful operation for manufacturers of chemicals, petro-chemicals, petroleum & foods. Bulletin #T-1159.
1 *General American Transportation Corporation

Reagent Feeders......Both wet & dry feeders available. Many standard units in stock. Bulletin F6-B8 give details and is now available on request.
125e *Denver Equip. Co.

Samplers......Continuous mechanical & automatic types for dry, solution or slurry sampling. Complete sampling plants & sample processing equipment. Bul. S1-B4.
125j *Denver Equip. Co.

Screens......Bul. S3-B15 covers Denver-Dillon Screens for efficient wet or dry screening. Sizes to 6' x 14' in stock. Trommel Screens in sizes 30" x 60" x 120".
125k *Denver Equip. Co.

Spiral Rake Thickeners......move settled materials to center in one revolution. Acid proof construction available. Bulletin No. T5-B6 is offered.
125l *Denver Equip. Co.

Pumps, Fans, Compressors

Compressors......WOC 22 Compressors are built to handle carbon dioxide, sulphur dioxide, chlorine & other highly corrosive gases. Full information in Bulletin 1012-11.
43 *Joy Mfg. Co.

Compressors......Standard models or designed to your specifications in any size of compressor, either centrifugal or axial-flow types. Bulletin, "Joy Turbodynamics."
45 *Joy Mfg. Co.

Pump, Chemical......The chemical positive displacement pump incorporates many outstanding features. Offers 500 R.P.M. maximum speed-200 lbs. P.S.I. Catalog P 302.
127 *Waukesha Foundry Co.

Pump, Suction......designed specifically to handle volatile sludges & slurries. Details on non-clogging slurry & sludge pumps contained in Bulletin 206-4.
160 *Lawrence Pumps Inc.

* From advertisement, this issue

LITERATURE . . .

Pumps......Types DL & DM offer capacities up to 1000 GPM & working pressure up to 300 PSIG. Head range to 430 ft. & temperature range to 450 F. Bul. B-1608.
135 *Food Mach. & Peerless Pump.

Pumps.....SRL (Rubber Lined) pumps offer high efficiency, low horsepower. Sizes to 5000 g.p.m. Additional information in Bulletin P9-B10.
125i *Denver Equip. Co.

Pumps......Turbine type, mixed flow & propeller type offer capacities of 50 to 100,000 GPM, heads up to 2,500 ft. Surface or underground discharge. Bulletins.
57 *Layne & Bowler, Inc.

Pumps......Single-stage, end-suction pumps are available in 10 to 2000 GPM capacities. Descriptive literature outlining all the features is available.
140 *The Weinman Pump Mfg. Co.

Pumps, Acid......Pumping parts available in a variety of metal alloys, as well as plastic, to cover a wide range of corrosive applications. Complete details.
163 *A. R. Wilfley & Sons, Inc.

Pumps, Chemical Feed......New 200 Series Simplex model can pump up to 812 gph. Duplex model has double this capacity. Maximum pressure of 10,000 psi. Details.
144 *American Meter Co.

Pumps, Diaphragm......Sizes 1" to 10" simples and duples, capacity to 1000 g.p.m. Stroke can be adjusted while pump is operating. Details in Bul. P8-B12.
125g *Denver Equip. Co.

Pumps, Vertical Centrifugal......for handling frothy liquids or coarse, sandy slurries, constant or intermittent flow. Capacity to 450 g.p.m. Bul. No. P10-B5.
125h *Denver Equip. Co.

Rotary Gear Pumps......Bulletin covers line of gear pumps of rotary design. Explains design features and presents detailed tables giving dimensions, capacities.
152A Northern Ordnance Inc.

Services & Miscellaneous

Copying Techniques......New 4-p. external house organ will show new and more efficient uses for office copying and engineering reproduction machines.
152B Anken Chem. & Film Corp.

Fire Extinguishing Systems......Revised booklet on fire extinguishing systems and equipment lists causes of large-loss fires, advantages of carbon dioxide systems.
152C Cardox Div., Chemetron Corp.

Safety......"Think Safety" is the theme of a series of 16 new safety posters that illustrate how accidents involving fork trucks occur and how to prevent them.
152D Automatic Transportation Co.

Water Treatment......Bulletin covers practical equipment for mixed-bed de-ionization at flow rates of from 5 gals. per hour up to 5000 gals. per minute.
152E Illinois Water Treatment Co.

* From advertisement, this issue

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Aluminum Evaporator Calandria type, never used. 1300 sq. ft. tube area.
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1—Sharple PN14 Super-D-Canters, 316 S.S.
1—AT&M 26" sus. Cent., perf. bskt., 316 S.S.
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5—Sperry 36" plate & frame Filters, rubber covered, cast iron, and wood.
5—8' dia. x 24' rubber lined Crystallizers.

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1—Renn. 6' x 60' Rotary Kiln, 5/8" shell.

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MISCELLANEOUS

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1—Bemis 50# Bag Packer with Sewing Machine, Conveyor and Flattener.
58—LaBour, Durco, Worthite, Duriron and Stainless Steel Centrifugal Pumps 2" to 6" with motors,

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Nooter 750 gal. Steel Reactor 300 PSI
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Vulcan 9'x100' Rotary Kiln
5'x45' Standard Rotary Dryer
Mosser 4'x47' Rotary Dryers
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1—550 sq. ft. Buflovak, monel single effect Evaporator.
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1—750 gal. nickel clad Mixing Tank, 125# nickel coils.
1—4000 gal. Haveg Vert. Tank 8'x12'.
1—1500 gal. Stainless Pressure Tank, 90#.
1—12,000 gal. horiz. steel pressure Tank, 7'6"x36', 200 PSI.
8—Stainless Heat Exchangers; 1220, 942, 786, 536, 396, 315, 250, 157 sq. ft.

CENTRIFUGALS

1—Sharples C-27 Super D-Hydrator, 316 S.S.
1—Bird 18"x28" 316 S.S. Solid Bowl, Continuous.
1—Bird 18"x28" steel, Solid Bowl, NEW, Continuous.
1—Bird 36"x50", 347 S.S. Solid Bowl, Continuous.
2—Sharples PY14, PN14, Super-D-Canters, 316 S.S.
1—Bird 40" suspended, 347 S.S. perforated basket.
2—Sharples #16, 304 S.S., 3 HP motor.

MIXERS

1—#12 Sturtevant 304 S.S. Rotary Mixer, 450 cu. ft.
1—Baker Perkins #16TRM, 150 gal. jktd., Vac. 60 HP.
5—Day "Cincinnatus" double arm, 250 and 100 gal.
1—1500# Powder Mixer, 7½ HP XP motor.
2—Steel, jktd. Powder Mixers, 225 and 350 cu. ft.
1—#0 Simpson Intensive Mixer.

DRYERS

1—National 8' x 80', 304 S.S. Apron Conveyor Dryer.
1—Louisville 54" x 35', Monel Rotary Steam Tube Dryer.
3—Buflovak Vacuum Shelf, 20-60" x 80" shelves.
1—Devine Vacuum Shelf with 19-59" x 78" shelves.
1—Devine Vacuum Shelf with 10-40" x 43" shelves.
2—Buflovak 42" x 120", atmospheric, double drum.
2—Devine 5' x 12', 4' x 9', single drum, atmospheric.
1—Baker Perkins 5'6" x 6' Rotary Vacuum Dryer.
1—Buflovak 3' x 20' Rotary Vacuum Dryer, 316 S.S. Unused.
2—Louisville Rotary Steam Tube 6' x 25', 6' x 50'.
4—Rotary Dryers, 4' x 40', 6' x 50', 7' x 80'.
2—Louisville 8' x 50' Stainless Steel Lined Rotary Dryers.
1—Traylor 30" x 18' Stainless Steel Rotary Dryer.
2—Link Belts; 7'5" x 25", 6'4" x 24', S.S. Louvre Dryers.

FILTERS

1—Oliver 6' dia. Horizontal Filter, 316 S.S.
1—Oliver 3' x 6' Steel Rotary Vac. Precoat Filter.
1—Niagara #370-38 Filter, 370 sq. ft., 304 S.S.
2—#49 Vallez Rotating Pressure Filters, 738 sq. ft.
1—Oliver 5'3" x 8' Steel Rotary Vacuum, vaporite housing.
1—Sparkler 33S28 Filter, 150 sq. ft. 304 S.S.
1—Niagara 36H110 Horizontal Filter, 110 sq. ft., 304 S.S.
2—#10 Sweetland Filters, 27 leaves, 4" centers, 250 sq. ft.

BRILL EQUIPMENT COMPANY
35 JABEZ STREET NEWARK 5, N. J.
Tel.: Market 3-7420 • Cable: Bristen
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From the ENTIRE STAFF of the FIRST MACHINERY CORPORATION and the FALCON MANUFACTURING DIV.

EQUIPMENT STILL ON LOCATION WHERE ORIGINALLY INSTALLED CAN BE PURCHASED FOR DIRECT SHIPMENT AT TERRIFIC SAVINGS

b-e-c-a-u-s-e

These units are NOT to be shipped into our New York shops and then reshipped to destination. You save such costs as rigging, double handling, freight charges etc.

NEW YORK STATE
(outside of New York City)

Bowen Stainless Steel Laboratory Spray Dryer—Complete. Robinson Size 17 Blender; 66"x14'; 380 cu. ft. Center Disch. J. H. Day Jacketed Mild Steel Double Ribbon Mixer; 4'x8' Acme Stainless Steel Concentrator or Dryer; Continuous Type consisting of 4 Units 24"x10' mounted horizontally; 20 HP Rotary Dryer in Monel; 4" Diameter by 30' Long; complete Jacketed Rotary Dryer or Roaster 4'x12'3"; Monel shaft-blades. Bucket Elevator with Stainless Steel material contact parts. Rubber Lined Mixing Tanks, Crystallizers, Evaporators to 800 Gal. Special Lot of CHEMICAL PUMPS; Duramet, Duriron, Olivite etc. Oliver Pressure Precoat Rotary Vacuum Filters; 8'x8'-8'x10'. Rotary Cooler 3'x15' with Feeder and accessories. 6 Southwark Hydraulic Presses; 36"x36" Platens; 14" Ram

NEW JERSEY

Feinc Stainless Steel Rotary Filter 5'x6'; string type. Patterson 1000 Gal. Dissolver; 84"x48"; 20 HP Unipower. Stainless Steel Rotary Dryer 4'x20' with Oil Burner etc. Bird Young Rotary Vacuum Filter 4'x4' with stainless leaves. Stainless Lined Heavy Duty Tanks; 11,000 Gal. 10'x18'7". Stainless Steel 7000 Gal. Horizontal Tanks; 6'x34' Gehnrich Truck Dryer; 12'x24'x7'6"; with 24 Trucks-Trays etc. Shriver 42"x42" Filter Presses; 4 eyed; closed delivery. Consolidated Capem Automatic Copper Model C4F complete

OHIO

Fatty Acid, Lurgi Type Distillation System including Ni-Resist Still Pots, Stainless Heat Exchanger, Vapor and Barometric Condensors, Receivers, Cooling Tanks etc. International Porc. Lined Pebble Mills 8'x8'; 50 HP Gear Motor Abbe Porc. Lined Pebble Mills; 30'x30"; 30"x42"; 37"x48"

ALABAMA

Swenson Quadruple Effect Long Tube Evaporator of the Vertical Film Type; 5 bodies

INDIANA

NEW Unused F-B. Two Roll Rubber or Plastic Mills 14"x30" with or without Uni-Drives

CALIFORNIA

Steel Reaction Kettle 1500 Gal.; Jacketed; 6'x5'2"
Louisville Stainless Steel Dryer 30"x28' complete
Glass Lined Agitated Tank; 6'x7' with 3 HP XPL motor
Jacketed Steel Ball Mill; 5'x2'6"
Abbe 6'x6' Buhrstone Lined Pebble Mill; 25 HP

ONTARIO CANADA

Stokes Impregnators (2 Tanks each 62"x6') Model 36-48 complete

WEST VIRGINIA

4 Struthers Wells Type 316 Stainless Steel Jacketed, Agitated Reactors; 6'x10'x14' Overall

VIRGINIA

Oliver Pressure Precoat Rotary Vacuum Filters 5'3"x8' STAINLESS
Oliver Pressure Precoat Rotary Vacuum Filters 5'3"x3' Steel

RHODE ISLAND

Type 316 Stainless Steel 250 Gal. Crystallizer; 85"x24" with Anchor Type Agitator; Bolted head; 24" Manhole
Patterson Kelly Twin Shell Stainless Steel Blender; 150 cu. ft. Motorized 10 HP
Pfaudler Thimble Condenser; Glass Lined; Double Jacketed; 26 sq. ft. International Porc. Lined Pebble Mill; 5'x6'; 15 HP Motor. Stainless Steel Cyclone Collector; 6'x7'.
J. P. Devine Lab. Vacuum Dryer Model "O"; 20" Dia x 3' long
Shriver Aluminum Filter Press; 24"x24"; 24 Chamber; 4 eye; closed del.
Multi Pass Stainless Clad Dryer; Four 10' Sections; 12" Jktd. Screw Conveyor
Pfaudler Glass Lined 150 Gal. Evaporating Dishes; 60"x24"

MASSACHUSETTS

Blaw Knox Tumbling Cone Type Blender; 300 Cu. Ft.; 9'x6"x45"; complete Abbe Steel Ball Mills; 42"x32"; 60"x48".

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Dewaterers: Davenport 3A, bronze hd. 3 hp.
Disintegrator: Rietz RD18-P, 75 hp.
Dryers: Devine 2 x 4' vac. drum, st. steel.
Dryer: Bowen lab. spray st. steel.
Dryer: Louisville 30' steam tube.
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Kettles: St. Steel, with and without ag. Dopp 150 gal. dbl. act. agitator.
Mills: Mikro Bantam, ISH.
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Colloid, 3, 5, 20, 25 hp.
Cog stain. steel, 10 hp.
Hammer: Williams, Jeffery, Prater, Ray.
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Dry Powder, various sizes.
Baker-Perkins size 17, 30 hp.
Mix-Muller Simpson 18" lab., 39½" Porto.
Percolator: Pfaudler 54 x 42" st. st. jack.
Pumps: Rotary, gear, centrif., vacuum.
Screen: Rotex model 41 st. steel.
Still: Double effect st. st. 11.83 gal.
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Vacuum Pan: 42" Harris st. steel.

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BALL MILLS—3' x 12' Abbe/40 HP—4' x 6' Allis Chalmers 60 HP Slip Ring/screwfeeder—Kennedy Van Saun 5' x 6' Enclosed gears/50 HP/scales/feeders/exhausters—Hardinge 6' x 12' w/200 HP Slip Ring/drum feeder.

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ROTARY DRYERS—24" x 22'—36" x 24'—44" x 25'—5' x 50' (2) all w/motor drives—burners/blowers avail.

VACUUM PUMPS—115 CFM Beach Russ 100 RP w/5 HP motor/Vee belt drive.

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Robinson 70 cu. ft. J'ktd. Steel Blender
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4 Mikro's-Bantam, #1SI, #2SI, #4, with motors
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BP 100 gal. 4 side Jktd Mixer, cored, sigma arms
Gruendler "BB" Hammermill, Whirlbeater
Gen. American 42"x120" twin Drum Dryer
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138 CFM 100 PSI 7x7 Ing. Rand ESI
162 CFM Vac. 10x5 IR-Vertical
238 CFM 100 PSI 9x9 ING. ES Worth HB
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465 CFM 100 PSI 12x11-IR-ES-1-Chic. P.T.
502 CFM 125 PSI 12x13 Chic. T
686 CFM 100 PSI 14x13 Ing. ES
823 CFM Vac. 18x7 Ing. ES-1
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Entire Facilities of New East Coast Plant

Marine Minerals Plant of Heavy Materials Co. — Clearwater, South Carolina
Built new in 1955 — Clearwater is 5 miles north of Augusta, Georgia

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1—60 Ton Portable Steel Concentrate with Athay Tracks, & 16" x 13' Akins Classifier
1—80 Ton Steel Storage, 10' x 10" x 10'
1—20 Ton Steel Storage, 6' x 6' x 10'

CAPACITOR
1—20 KVAR General Electric, 440 V

CLASSIFIER
1—24" dia x 15' Akins Spiral, 2 HP drive

CONVEYOR, BELT
1—6" x 27' Carpco Conveyor, BC-68, 3/4 HP Motor
1—6" x 13' Carpco Conveyor, BC-68-112, Mag. Pulley & Drive
2—6" x 36' Carpco Conveyor, BC-68, 3/4 HP Motor
3—6" x 44' Carpco Conveyor, BC-68-105, 3/4 HP Motor
1—6" x 48' Carpco Conveyor, 3/4 HP Motor
1—6" x 28'-4" Carpco Conveyor, BC-1214, Mag. Pulley & Drive
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1—30" x 51' Belt Conveyor, 5 HP Motorized head pulley

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1—30 HP American Hoist & Derrick, 37' Mast

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2—12" x 8' Carpco Dewatering Screws, DS12, 1/2 HP

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1—6 cu. ft. Yuba Mfg. Electric Bucket Line Complete with Drive & Conveyors

DRILL
1—Model 1500 Failing Drill rig with Int'l Truck L-164 1957 model, Complete

DRYER
1—48" x 31'-3" Hardinge rotary, XFZ, Gas Fired, Complete
1—36" x 13' Hardinge rotary, XFO, Gas-oil Fired Complete

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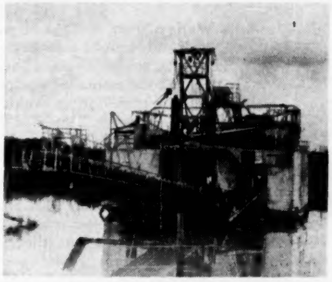
27—Carpco, Vertical, 23' - 33' high, 4" and 6" Bucket, w/motor

FEEDERS
1—12" x 5' Carpco Vibrating, with motor
1—8" x 23 1/2" Carpco Vibrating, plate, SH 124, 1 HP Motor
1—Rotary Plate Feeder and 12' x 9' Bin, 2 HP Motor
1—20" x 6' Shaeffer Poidometer Feeder
1—10" x 44" Shaeffer Poidometer Feeder



6-cu. yd. Yuba Dredge

HIGH TENSION SEPARATORS
3—HS-418 Carpco High Tension Separator, w/Drive
1—HS-218 Carpco High Tension Separator, w/Drive
5—HT-460 Carpco High Tension Separator, w/Drive

JIGS, MINERAL
1—12" x 12" Pan American, 1 cell Type PE-1
1—12" x 12" Pan American, 6 cell, w/Drive
1—24" x 24" Yuba, 2 cell w/Drive

KILN
1—48" x 30' Hardinge Rotary, XL2, Gas-oil Fired, Complete

LATHE
1—30" Swing x 12' Bed Lodge and Shipley Quick Change

LOADER
1—Model 75A Michigan, hydraulic, 1 cu. yd.

MAGNETIC SEPARATORS
1—MI-318 Carpco Magnetic Separator w/Drive
1—MI-218 Carpco Magnetic Separator w/Drive
6—MI-418 Carpco Magnetic Separator w/Drive
1—D-1A Exolon, 3 units Vertical Roll Type, w/Drive
1—E-10, Dings Cross Belt, 18"

PIPE
3740'—8" Spiral Weld, AR Plate

PUMPS
1—3" Ingersoll Rand 3RVH-40, 220/440V
1—3" Allis Chalmers, 220/440V
1—6" Allis Chalmers 50HP 220/440V
1—3" Allis Chalmers, 100 HP, 220/440V
1—3/4" Carpco Warman, 3 HP, 220/440V
1—2" Georgia Iron Wks. Slurry Fig. 2312-G, 10 HP, 440V
1—3" Ingersoll Rand 3RVH 30, 220/440V
1—3" Crane 6 MOL Deepwell Turbine, 7 1/2 HP
1—3" Georgia Iron Wks. Slurry, 5 HP

RECTIFIER
1—7 1/2 KW Accurate Engineering, 115V DC, 65A
1—5 KW Accurate Engineering 115V DC, 65A
1—Carpco Rt. Rectifier, High Voltage, 0-40, 000V
1—Carpco Selenium, R12-107, 115V DC
1—Carpco, Transformer Type AC-29

SAMPLER
5—21" Denver Equipment Co. Type SL

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1—20 Ton Winslow, Type P, Truck, 24' x 9'

SCREENS
2—6' x 12' Allis Chalmers Lowhead, 1 deck
1—3' x 5' Tyler Hum-mer, 1 deck
1—18" x 48" Overstrom, 1 deck, 2 HP
1—4' x 8' Tyler, 1 deck, Type 38

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2—BXM-100 Sutton, Steeled Steel, Single Deck, Air Type, 10 HP
1—BXM-200 Sutton, Steeled Steel, Single Deck, Air Type, 10 HP
4—#6 Std. Wilfley Concentrating 1 1/2, 220/440V
1—#12-S Wilfley Concentrating, 1 HP, 220/440V
1—#13 S Wilfley Concentrating, 3/4 HP, 220/440V

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3—25 KVA General Elec. 2400-240/480V, Modern
3—75 KVA General Elec. 2400-240/480V, Modern
3—125 KVA General Elec. 2400-440V

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1—250 Amp Lincoln, Portable, Elec. Drive
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Centrifugals: 12", 30", 40" & 48".
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Vac. shelf, Atmos. & Rotary Dryers.
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3 Roll, 9" x 32", 12" x 30", 16" x 40".
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Mixers: Baker Perkins Jack, 100 gals.
Day Imperial 75 & 150 gals.
Change Can Mixers 8, 15, 40 gals.
Day Jumbo 700 gal, horiz. mixer.
Sturtev, 1 ton Drum Blender 10 HP.
Blystone 3000# horiz. spiral mixer.
Day 1000# Spiral Mixers, & up to 3000#.
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Pumps: Stokes etc. Vac. 10 to 500 CFM.
Gould 75 HP. Centrifugal 250 PSI.
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New 14" x 30" Rubber & Plastic Mills.
Hydr. Presses, Plastic & Rubber Machy.

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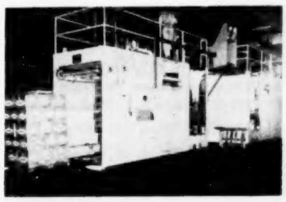
1954 ALVEY PALLETIZERS
at approx. 1/2 of original cost



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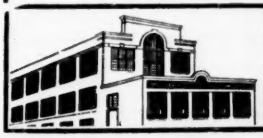

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500,000 ft 10 3/4" O.D. 35#
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FOR CHEMICALS
Stainless Steel - new and used.
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MAyfair 1-2363

JUST PURCHASED

2—Patterson 6' x 8' porox pebble mill, 50 HP gearhead drive, 1947—like new.
1—Link-Belt #604-18 roto-louvre dryer, 6'4" dia. x 18' long, w/cyclone, fans, etc.

STOCK ITEMS

STAINLESS REACTORS—KETTLES

1—3500 gal. T316 SS, jkt. & agit.
1—2200 gal. T316 SS, jkt. & agit., VAC.
1—1300 gal. T304 SS, jkt., 5 HP XP agit.
2—750 gal. T304 SS, jkt. & agit.
1—500 gal. T304 SS, jkt. & agit.
6—465 gal. T304L SS, jkt. & agit.
1—350 gal. T304 SS, jkt. & agit.
2—125 gal. T316 SS, jkt.

ROTARY KILNS—DRYERS

1—11' x 155' Traylor, ⅞" shell Kiln.
3—10' x 80' rotary dryers, ¾" shell.
1—8' x 125' Kiln, ⅝" shell.
2—7'6" x 100' ½" shell Kilns.
1—7'6" x 60 Kiln, ½" shell.
2—Hardinge 8'8" x 70' dryers, ⅝" shell.
1—7'6" x 60' dryer, ½" welded shell.
1—Allis-Chalmers 7' x 50' dryer, ⅝".
1—6' x 50' Louisville dryer.
6—Steel dryers: 5'6" x 50', 4'9" x 32', 4'6" x 40', 4' x 30', 3' x [illegible]
2—Stainless dryers: 4'6" x 12', 3' x 10'.

TANKS

1—8000 gal. T304 SS, vert.
12—4500 gal. nickel-clad, vert. 125#.
1—3000 gal. alum., vert., open.
1—10,500 gal., T304 SS, horiz., UNUSED, dished heads.
2—5700 gal. T304 SS, horiz., UNUSED.
4—Vacuum tanks w/coils, T304 SS: 3700, 3000, 2350, 1750 gal.
1—3400 gal. T304 SS, horiz.
1—2000 gal. T316 SS, hopper.
8—1750 gal. T304 SS, hoppers.

JUST PURCHASED

1—Kennedy 7' x 9' contin. ball mill, integral herringbone drive, 1948—150 HP. Like New!
1—10' dia. x 230' long rotary Kiln.

LIQUIDATING

CHEMICAL PLANT—ORANGE, TEXAS

1—Struthers Wells 630 sq. ft. T316 SS evaporator.
2—1,800 cu. ft. Read weight hoppers, T304 SS, 11'10" x 10'5" x 10'2", hopper bottom, fulcrums, scales avail. w/bucket elevators, conveyors, etc.
3—Worthington 160 ton steam-jet vacuum refrigeration units.
3—18,000 gal. alum. cone-bottom tanks, 12' x 31' OAH.
2—Buffalo T316 SS blowers, 2330 cfm, 60 HP, TEFC motors.
2—American T316 SS blowers, 5600 cfm., 50 HP, TEFC motors.

CENT.—FILTERS—CRYSTALLIZERS

2—Sharples #16-P Pressurtite, T304 SS.
2—Sharples C-20 Super D-Hydrators, T316 SS.
1—Alco 110 sq. ft. pressure leaf filter, T316 SS.
4—Struthers-Wells vacuum crystallizers, 1200 gal., T316 cone bottoms.
1—Eimco T304 SS rotary vac. filter, 18" dia. x 24" face.

EXCHANGERS—CONDENSERS—COOLERS

12—800 sq. ft. T316 SS heat exchangers, removable bundle.
75—T316 tubular heat exchangers & condensers, 2000, 1450, 880, 800, 750, 600, 530, 427, 400, 300, 264, 250, 235, 200, 185, 165, 150, 125, 64, 50, 47, 30 sq. ft.
25—Copper & Cupro-Nickel heat exchangers & condensers, up to 1070 sq. ft.

TYPE 316 SS KETTLES

1—3,500 gal. Struthers-Wells vert., 7' dia. x 12" high, jacketed, int. coils, 40/20 HP agit.
1—2,830 gal. horiz. still kettle, 6' x 12' 100 sq. ft. int. coil.
2—2,250 gal. vert., 7' dia. x 6'3" high, jacketed, 3 HP agit.
1—2200 gal., 6'6" x 8', vacum, jacketed, agit, T316 SS.

TYPE 316 STAINLESS STEEL PRESSURE TANKS

1—17,650 gal. horiz., 9' dia. x 36' long, ¼" shell, ⅜" dished heads, 40# WP
1—2,830 gal., horiz., 6' x 12', 5/16 shell & dished heads, VACUUM, or 80# WP
3—2,750 gal. vert., 7' x 8', dished heads, int. coils, 50# WP
9—2,600 gal. vert., 7' x 8', int. coils, (some w/agit), 19# WP
5—2,250 gal. vert., 7' x 6'3", dished heads, (some w/agit., some w/jacket), 70# WP
2—1,900 gal. vert., 6' x 8', ⅜" shell & dished heads, VACUUM, or 100# WP
4—1,200 gal. vert., 5' x 7', dished top, cone bot., VACUUM, or 100# WP
6—685 gal. vert., 3' x 13', internal coils.
1—575 gal. vert., 4' x 6', dished heads, 90# WP, 355 sq. ft. int. coils.
50—Tanks & pots, 30 to 500 gal., T 316 SS.

COLUMNS—STAINLESS STEEL

1—110" dia. Vulcan, 10 trays—bubble caps, T316 SS.
2—96" dia. Vulcan, 30 trays—bubble caps, T316 SS.
1—96" dia. Vulcan, 10 trays—bubble caps, T316 SS.
2—60" dia. Vulcan, 10 trays—bubble caps, T316 SS.
1—48" dia. Vulcan, 25 trays—bubble caps, T304 ELC SS, 100 PSI.
3—24" dia. Vulcan, 12 trays—bubble caps, T316 SS—VACUUM.
6—T316 SS Packed Columns: 42", 36", 30" dia.
5—Steel Packed Columns: 60", 48", 36", 30", 20".

COLUMNS—COPPER

5—Vulcan copper bubble-cap columns, VACUUM! 72" x 40 plate; 48" x 25 plate; 48" x 22 plate; 24" x 20 plate.

SEND FOR
LATEST INVENTORY LIST #859-A

MISCELLANEOUS EQUIP.

2,000 T316 SS flanged valves, globe or gate, ½", 1", 1½" up to 12".
10,000—T316 SS pipe, schedule 40, 10, 5, sizes ½", 1", 1½", 2" up to 12".
35—T316 SS pumps, sizes from 6" x 5" to 1" x 1".
1—Otis elec. freight elevator, 5,000# capacity @ 75 FPM.
2—Stainless steel reboilers.
2—Stainless steel bucket elevators, 60' & 40' high.
1—2,100 gal. vert. alum. tank, coils.
10—T316 SS separators, 22" x 8' deep.
1—2,000 gal. copper tank.
3—18,000 gal. steel tanks.

SEND FOR CIRCULAR

PERRY EQUIPMENT CORPORATION

1413-21 N. SIXTH ST. PHILADELPHIA 22, PA.

Phone POplar 3-3505

The net of it all is this—
GELB
CHEMICAL PROCESS EQUIPMENT
Costs Less—Does More

2—Pfaudler 750 gal. glass lined jacketed reactors
9—Davis Engineering SS heat exchangers 145 sq.ft (NEW)
1—Shriver aluminum 30"x30" plate and frame filter press, 30 chambers
2—Fletcher 40" suspended type rubber lined centrifuges with perforated baskets and motors.

THE GELB GIRL—DECEMBER 1959

AUTOCLAVES KETTLES AND REACTORS

2—Horizontal stainless steel 3000 gal. storage tanks
1—Steel and Alloy Tank Co. 100 gal. type 347 SS pressure tank, 250 psi jacket
1—Blaw-Knox 400 gal. steel jacketed autoclave, 570# internal pressure, 85# jacket
1—Blaw-Knox 45 gal. jacketed autoclave, 1500# pressure
1—Process Engineers SS jacketed reactor, 1500 gal., 140# W. P. jacket, 150# W. P. shell
1—Steel & Alloy Tank Co. SS jacketed tanks, 500 gal. each
2—Pfaudler 200 gal. glass lined reactors with impeller type agitators and drives
1—Pfaudler 500 gal. glass lined jacketed reactor, complete with impeller type agitator, baffle and drive.
1—Pfaudler 50 gal. glass lined jacketed reactor complete with agitator and drive
1—Edgemoor type 316 SS 750 gal. jacketed reactor
1—Struthers Wells 500 gal. nickel jacketed reactor
1—Patterson-Kelley 6000 gal. steel jacketed reactor, 40# jacket, complete with agitator and drive
1—Patterson 2000 gal. steel jacketed reactor
2—Haveg 300 gal. pressure vessels complete with agitators and drives
28—30,000 gal. steel vertical storage tanks

DRYERS

1—Link Belt steel roto louver dryer, Model 1003-30
3—Link Belt steel roto louver dryers, Model 207-10, 310-16, 604-20
2—Stokes Model 138J-20 single door vacuum shelf dryers, 20 shelves, complete
1—Stokes Model 59DS steel rotary vacuum dryer, 5' x 30'
1—Buflovak SS rotary vacuum dryer, 3' x 15'
1—Stokes double drum dryer, 5' x 12'
1—Louisville rotary steam tube dryer, 8' x 45'
2—Louisville SS rotary dryers, 8' x 50'
1—Louisville SS rotary kiln, 30" x 28' complete
1—Louisville Rotary dryer, 38" x 40' Type L
1—Ruggles Coles 4' x 30' rotary kiln
1—Traylor 4' x 40' rotary dryer
1—Rotary dryer 6' x 36'

FILTERS

3—Dorrco rubber covered filters, 6' x 2'
1—Sweetland #3 stainless steel filter
1—Niagara SS filter, Model 510-28
1—Oliver horizontal filter, 3'
10—Shriver plate and frame filter presses, 12" to 42"
1—Shriver C.I. plate and frame filter press, 36" x 36" closed delivery, 4 eye, 60 chambers
1—Shriver rubber line filter press 36" x 36"
12—Sweetland #12 filters with 72 SS leaves

CENTRIFUGES

1—Tolhurst 40" SS suspended type centrifuge complete with plow and motor with imperforated basket
1—Tolhurst SS 20" suspended type centrifuge with perforated basket, complete with plow and motor
1—AT&M 26" suspended type centrifuge with SS perforated basket, complete with plow and motor
1—AT&M 48" SS suspended type centrifuge, complete with plow motor and imperforated basket
1—Bird type 316 SS centrifuge, 32" x 50"
4—Tolhurst 30" center slung rubber covered centrifuges with perforated baskets and motors
18—Sharples SS centrifuges, Model 16Y

MIXERS

15—Robinson type 304 SS horizontal blenders, 255 cu. ft. each
3—Robinson type 316 SS sigma blade jacketed heavy duty mixers, 400 gal.
1—Baker Perkins Size 16 Type UUEM 150 gal. jacketed double arm dispersion type mixer, complete with compression cover and 100 HP motor.
2—Sturtevant #7 dust type rotary batch blenders, NEW
1—12' x 4' pug mixer, type 316 SS
1—Patterson type 34 7SS jacketed vacuum sigma kneader master, 500 gal.

MISCELLANEOUS

1—Cleaver-Brooks 500 HP package steam generator, 200#
2—Cleaver-Brooks package steam generators, 50 & 80 HP, 125#
2—Heat Transfer Products steel bubble cap columns, 36" and 42" with 5 and 10 trays
1—Acme steel bubble cap column, 42" dia. with 10 trays
1—Badger type 316 SS bubble cap column, 42" dia. with 11 trays
1—Badger type 316 SS bubble cap column, 36" dia. with 8 trays
1—Vulcan SS bubble cap column, 4' x 28 plates
2—Patterson-Kelley steel heat exchangers, 1000 sq. ft. each
6—Struthers Wells heat exchangers, 885 sq. ft.
1—Patterson-Kelley steel heat exchanger, 427 sq. ft.
50—Steel heat exchangers from 15 sq. ft. to 400 sq. ft.
1—Downington type 316 SS heat exchanger, 750 sq. ft.
1—Struthers Wells type 316 SS heat exchanger, 330 sq. ft.
1—Condenser Service type 316 SS heat exchanger, 350 sq. ft.
3—Badger type 316 SS heat exchangers, 500 sq. ft. and 600 sq. ft.
3—Robins shaker screens, SS, 3' x 6'
1—Swenson type 316 SS vacuum crystallizer, 3'6" x 12'
1—Swenson type 316 SS vacuum crystallizer, 2' x 12'
1—Blaw-Knox steel distillation column, 36" x 40' with 24 trays (NEW)
3—Williams type 316 SS hammermills, Model AK
1—Swenson SS pilot plant spray dryer

1—Oliver SS rotary pressure precoat filter, 5'3"x8'
1—Glenn SS 340 qt. mixer
1—Sprout Waldron Model 501-D pelleter
1—Stokes Model T tablet press

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